COVID-19 - SOCIAL SCIENCE RESEARCH DURING A PANDEMIC

EDITED BY: Paul Russell Ward, Paul Bissell, Samantha B. Meyer, Hailay Abrha Gesesew, Pande Putu Januraga, Dukjin Chang and Linda Lombi

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Editorial on the Research Topic

COVID-19-Social Science Research During a Pandemic

A huge number of epidemiological, clinical and laboratory studies have been published to mitigate the coronavirus pandemic crises and the findings from these studies are helping policy makers to understand how best to manage the current and future clinical and public health responses. In addition to impacting on infection and mortality rates due to COVID-19, government responses to reducing viral spread and "flattening the curve" have meant huge impacts on social and economic life across the globe. But research is also needed to explore the social and economic impacts of COVID-19 to assist policy makers to understand the impact of current interventions and plan future policy to mitigate unintended consequences of pandemic responses. In particular, the impacts of responses which brought social disruptions such as: closing down parts of the economy and increasing unemployment, forcing some people into "social isolation", restricting freedom of movement, closing schools/universities/workplaces, reducing democratic decision making of governments and generally disrupting the 'social order' of the pre-COVID-19 world are less investigated.

As part of this investigation, by the 12th of May 2020, a special topic entitled "COVID-19–Social Science Research during a Pandemic" was initiated by a dedicated team of scholars as guest editors to facilitate the timely peer-review and publication of relevant manuscripts from multiple studies (1). A total of 111 manuscripts were submitted between 12 May 2020 and 1 January 2021 of which 37 manuscripts were rejected while 74 manuscripts from 298 contributing authors from all over the globe including China, Italy, US, Indonesia, and Saudi Arabia were published. Population in the studies included students, health workers, men who have sex with men (MSM), and general population.

By March 2022, the special topic achieved over 1.06 million views. In this special issue, several thematic areas were highlighted including but not limited to:

(a) Knowledge, attitude and practices to COVID-19 and its preventive measures— for example, Purnama et al. noted the continued practice of stay at home, physical distancing, and always using face masks for the public to have a supportive attitude, and Albaqawi et al. revealed good perceptions of COVID-19 knowledge and its prevention among Saudi Arabia nursing students, and positive perceptions on the government's effort in responding to the COVID-19 crisis.

(b) Policy interventions to fight COVID-19 pandemic such as pharmaceutical and non-pharmaceutical strategies—for example, Giudici and Raffinetti suggested Gini-Lorenz concentration approach to monitor COVID-19 policy interventions and Goldman's demonstrated Voluntary Cyclical Distancing as alternative approach to social distancing.

(c) Impacts of COVID-19 and its preventive measures such as increased alcohol consumption, mental illness, unintended breast cancer, human rights violations, and stigma and discrimination, and diminishing quality of life— for example, Septarini et al. reported moderate to very high psychological distress and lack of happiness during the COVID-19 pandemic among MSM in Indonesia, Lunnay et al. depicted increasing in alcohol consumption among Australian women in the emerging affluent group who experienced increased feelings or fear and anxiety during the COVID-19 pandemic, and Santos et al.'s demonstrated collision of fundamental human rights and the right to health access as a result of the preventive measures.

(d) Media and COVID-19 pandemic especially on the role of media on framing political consequences and responsibility—for example, Jo et al.'s reported media's framing on quarantine performance in South Korea bringing a positive change in people's attitudes toward the government and Thomas et al.'s added media's lack of blame of COVID-19 pandemic in Australia.

(f) Others including Trust during and post-COVID-19 pandemic such as strategies to maintain public trust,

COVID-19 and HIV co-infection, poverty and death due to COVID-19, telehealth and COVID-19 pandemic, and childhood immunization and COVID-19 protection—for example, Henderson et al.'s 10 strategies of maintaining trust in public health officials, Gesesew et al. findings on intersecting nature of the COVID-19 and HIV pandemics to identify a shared research agenda using a syndemic approach, and Beric-Stojsic et al. findings on the potential protective role of BCG, MMR, and HEP-A childhood vaccines to COVID-19.

We hope that our Edited special issue provides empirical and theoretical evidence on the social impacts of the COVID-19 pandemic and food for thought for managing the social and emotional impacts of future pandemics.

AUTHOR CONTRIBUTIONS

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The Science of the Future: Establishing a Citizen-Scientist Collaborative Agenda After Covid-19

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While we are writing, many countries are still dealing with Covid-19 outbreak and many are moving toward a gradual easing of the restrictive measures. In the meantime, the role of scientists in the public community is silently, yet dramatically changing. Decision-makers are asking research experts to provide evidence on which political acts should be grounded. Citizens are insecure and they wonder how they are supposed to protect themselves from the contagion and when the vaccines will be available (1). The media coverage of the pandemic features a daily presence of scientists and public health professionals on the television and on the web, highlighting the key role of experts to deal with the emergency, but making also clear that any solution is still far from being conclusive.

It is increasingly becoming evident that the time needed for public health and scientific advance exceeds the time expected by citizens to obtain satisfactory responses. In a way, science is slow, uncertain, discordant, and fragile; and the increasing public awareness of its probabilistic nature (2, 3) may change the public perception of scientific knowledge for a long time. Lessons learned from previous epidemics suggest that disasters can affect the public understanding of science and the citizens' trust in scientist and experts (4). As for the Covid-19 emergency, a recent Italian study by Battiston et al. (5) suggests that while an initial increase in attention and information-seeking from scientists was registered on social media in February—the very start of the epidemic in Italy—, a dramatic decline in trust toward scientific and health authorities occurred in March 2020. As a result, the unprecedented and massive exposure of science to the public—together with the lack of definitive responses to citizens' needs—risks to end in a dramatic loss of trust in science (5).

THE CITIZEN SCIENTISTS AND THE COVID-19 EMERGENCY

Of course, science represents the best product of human cultural evolution. And still it is the kind of knowledge we can rely on to cope with this unprecedented worldwide healthcare emergency (4). Notwithstanding, the scientific field is now at an historical turning-point that should not be underestimated. Researchers have now the opportunity to redefine their relationships with the society. The notion of the "citizen scientist" has been increasingly highlighted in many different contexts in which the reciprocal partnership and engagement among researchers, citizens and policy makers was recognized as key to the success of multi-stakeholders initiatives (6). In environmental health, citizen science informs research questions, data collection and analysis, and conclusions that can impact the quality of life in local environments. The active citizens' participation in large-scale genome projects can empower even marginalized groups and

minorities in shaping scientific inquiry through participation (7). The distributed availability of smart devices catalyze the potentials of citizen-driven data for many different scientific fields, from public health to biology, from physics to ecology.

Now, the Covid-19 emergency is requiring that science and society work together to share needs, resources, actions and solutions. For example, in order to develop accurate and reliable models of the contagion spread, researchers need citizens to allow their real-time position tracking through apps and devices, thus making them the frontline data collector subjects (8). At the same time, clinicians and researchers need citizens to be engaged in respecting the mitigation and containment norms to adequately deal and reduce the virus spread (9). Citizens also need to trust scientists and researchers, as they are the experts holding theoretical and pragmatical knowledge, skills and resources to achieve the discovery of reliable and effective pharmacological therapies for the Covid-19. Honestly, this is not new. But the community impact of Covid-19 and its media coverage is increasing the awareness of citizens about the role of research for their life (10). Moreover, previous research suggests that the heightened media exposure to Ebola-related stories was related to increased distress, worries, and confusion in the citizens (11).

PUBLIC HEALTH OPPORTUNITIES FOR SCIENTIFIC CITIZENSHIP

While this pandemic is challenging the relationship between science and the people, it is also true—as it is for any crisis in life—that it holds potentials and opportunities. Here, we would like to highlight some of the valuable opportunities hidden in the actual pandemic for the evolution of public health science. In general, these potentials require us to consider the active engagement of citizens as a pivotal—rather than ancillary or secondary—element in every research step (12).

First, the communication of science to naïve readers and the public is challenged. Although many scientists may still be reluctant in investing time and resources in public communication of science and technology (13), reach-out communications cannot be anymore supplementary. Rather they need to be a relevant element of scientific plans. Not surprisingly, during the last decade, reach-out communication strategies are increasingly requested by international funding agencies as core elements of research projects and they contribute to the evaluation process of scientific applications. As the Covid-19 health emergency is paralleled by the risk of a pandemic of social media panic (14), these communications should favor citizens' comprehension and curiosity, rather than serve sensationalistic goals that may ultimately increase panic reactions.

Second, science should communicate and explain its processes in a way that is robust, yet understandable by the public. Public communication of science during the Covid-19 emergency should promote—more than ever—the exchange of balanced information and the engagement of the citizens as necessary active participants in a complex health information environment (15). How are findings obtained? What does it mean that a finding is "true" or "reliable" from a probabilistic point of view? Scientists should be able to explain—avoiding technical jargon— why research findings are something to be understood, and not something that require faith.

Third, truly collaborative models will need to be guided and shaped by flexible yet clear guidelines (16). Although there might be skepticism among some researchers about the quality of citizen-collected data (7), both methodological and statistical approaches are now available to promote high-quality citizen science projects. Collaborative models of science should reside in the middle of the spectrum between citizen- and scientist-initiated projects (17). The development, validation and acceptance of these guidelines (16) should be itself a co-designed initiative in which both researchers and citizens should play an active and dialogic role. The opportunity to invest in participatory citizen science projects during and after the Covid-19 pandemic should not be loss. Specific directions for advancing the field include (a) improving secure open-source data management tools, (b) promoting projects with real and concrete local effects for citizens in the place where they live, (c) and creating and/or strengthening networks of research consortiums to reduce redundancy and optimize resources among different local projects (7).

Fourth, without a proper methodological education, the "citizen scientist" may easily become an empty claim among scientists (12); a value with which no one of us disagree, but that ultimately fail in promoting reciprocal and mutually beneficial partnerships. To avoid this risk, scientists should be educated to recognize that citizens are already engaged in science by definition, as everything in science talks about them (16). Delivering effective education programs is a core part of the citizen science agenda (7). Investing in the education of new generations of scientists and researchers on citizen science appears to be a major goal of science educational programs after the Covid-19 outbreak in order to value and advance citizens' agency in science.

PAVING THE WAY FOR THE PUBLIC HEALTH SCIENCE OF THE FUTURE

The Covid-19 is probably going to change our lives for many years to come. The socio-economic and emotional burden of this pandemic will require relevant efforts from government and social community and the societies that will re-emerge from this 2020 emergency will no longer be the same. So, there is no reason to believe that science itself—and the way it produces narratives about its progress—will not be affected. More than this, we argue that public health research should be transformed, in order to take its role in the responsible steering of the post-Covid-19 society to a new form of participatory and collaborative engagement approach to research. The partnership among citizens, clinicians and scientists is no longer deferrable and the year 2020 appears to be a point of no return to plan the science of the future.

AUTHOR CONTRIBUTIONS

SB and LP conceived the ideas behind this work and refined the final version for submission. LP drafted the initial version of the manuscript. Both authors agreed on final submission.

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Living With COVID-19: A Systemic and Multi-Criteria Approach to Enact Evidence-Based Health Policy

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The lifting of COVID-19 (coronavirus disease 2019) lockdown requires, in the short and medium terms, a holistic and evidence-based approach to population health management based on combining risk factors and bio-economic outcomes, including actors' behaviors. This dynamic and global approach to health control is necessary to deal with the new paradigm of living with an infectious disease, which disrupts our individual freedom and behaviors. The challenge for policymakers consists of defining methods of lockdown-lifting and follow-up (middle-term rules) that best meet the needs for resumption of economic activity, societal wellbeing, and containment of the outbreak. There is no simple and ready-to-use way to do this since it means considering several competing objectives at the same time and continuously adapting the strategy and rules, ideally at local scale. We propose a framework for creating a precision evidence-based health policy that simultaneously considers public health, economic, and societal dimensions while accounting for constraints and uncertainty. It is based on the four following principles: integrating multiple and heterogeneous information, accepting navigation with uncertainty, adjusting the strategy dynamically with feedback mechanisms, and managing clusters through a multi-scalar conception. The evidence-based policy intervention for COVID-19 obtained includes scientific background via epidemiological modeling and bio-economic modeling. A set of quantitative and qualitative indicators are used as feedback to precisely monitor the societal-economic-epidemiological dynamics, allowing tightening or loosening of measures before epidemic damage (re-)occurs. Altogether, this allows an evidence-based policy that steers the strategy with precision and avoids any political shock.

Keywords: COVID-19, population medicine, systemic approach, evidence-based policy, social-ecological system (SES)

INTRODUCTION

The coronavirus disease 2019 (COVID-19) pandemic has been perceived as a major, unprecedented public health threat sparing no country with a speed of onset that has lead policymakers worldwide to implement drastic control measures very quickly (1). The first objective was to avoid a massive mortality burden, which led to extensive lockdowns to contain the dissemination of the outbreak. As days pass, lockdowns prove effective in limiting public health damage, while, at the same time,

social movements rise to advocate for freedom to work and circulate (2). Indeed, COVID-19 represents a change in paradigm for our society and the healthcare system. In the last few decades, outbreaks have been maintained locally and have been limited over time, which makes COVID-19 a novel entity (3). The management of infectious disease can follow two alternative strategies: the first one is to eradicate the disease, and the second one is to learn to live with the disease and mitigate its impact. As of mid-2020, eradicating a disease such as COVID-19 seems not to be an option: vaccines are not available, protective immunity after infection is challenged, and immunity duration is unknown; moreover, quick development of herd immunity would likely come at high public health costs, with a significant number of deaths and a large healthcare expenditure.

Living with COVID-19 will lead to substantial changes in individual freedom and behaviors and directly change medical, economic, societal, and political stakes worldwide. The very challenge for policymakers consists of implementing a sustainable approach for the economic and social sector, which will require the lifting of restrictions sooner or later. The ultimate goal of lockdown-lifting is to mitigate the impact on the country's economy and on the well-being of individuals while containing the spread of the outbreak in a way that is manageable for the healthcare services, without having to face ethical dilemmas such as equity in healthcare or additional risks of death in case of infection. The optimal lockdown-lifting method would be the one that best meets these four objectives (mitigating the spread of the outbreak, maintaining economic activity, and social well-being, and ensuring political stability) in both the short and the long terms.

This crisis reveals the difficulty of implementing responses to seemingly simple problems (a single infectious agent) but which are actually fundamentally complex and gaining acceptance of them by citizens. This observation is not new in the public health literature, and academics, as well as some institutions, invite policymakers to pledge policies accounting for multiple parameters. Additionally, political scientists have analyzed agenda-setting in light of the interdependence of people acting in a political and institutional context (4, 5). In the case of COVID-19, a context of emergency leads to the envisioning of responses articulating (i) biological and economic constraints, including the behavior of individuals, and (ii) high biologic and economic uncertainty. These facts lead to the seeking of original solutions that are able to handle multiple criteria simultaneously and are sufficiently acceptable by individuals (for their own safety and for compliance with rules for collective purposes). A holistic approach to health management, beyond outbreak management, is therefore necessary (6). It should dynamically handle multiple risk factors and multiple economic and biologic outcomes and be customized at various geographical scales. Such an approach must combine medicine, epidemiology, and economics and differs from normal epidemiological approaches centered on an infectious agent or a syndrome.

We propose to lay down the characteristics of a holistic approach, accounting for several objectives and different time steps, that is required to manage lockdown-lifting and the COVID-19 endemic situation.

To do so, we rely on social-ecological approaches developed in the field of environmental economics and in public health policy. In Ostrom's "diagnostic approach," the Social-Ecological System (SES) framework was designed to address coordination problems of natural resource management and help prioritize the most relevant variables (7, 8). SESs are complex adaptive systems with many locally interacting components evolving with non-linear dynamics, sometimes unpredictably (9, 10). Adapted to the current COVID-19 situation, the SES relates outcomes such as health, well-being, and economic welfare to interactions between humans, e.g., number of contacts or conflicts among people, which are influenced by the resource system, the governance system, and users in a given social, economic, and political setting.

In parallel, a significant amount of literature advocates for systemic approaches in public health (11). One way to measure interactions between factors affecting health is to use the Social Ecological Model (SEM) (12). This model studies how the physical, social, and cultural dimensions and political environments of the individual, as well as their personal characteristics, influence health, well-being, and social cohesion. The SEM recognizes interactions across individuals embedded within larger social systems and describes the characteristics of individuals and environments that underlie health outcomes. In the SEM, each level overlaps with other levels. Hence, defining the best public health strategies requires that a wide range of perspectives be targeted.

Although our purpose here is not to investigate how to adapt the previously cited models to COVID-19, we emphasize the importance of accounting for multiple variables simultaneously with the perspective of complex adaptive systems (9, 13).

WHY DOES THE MANAGEMENT OF LOCKDOWN-LIFTING AND OF AN ENDEMIC INFECTIOUS DISEASE RAISE QUESTIONS FOR THE SCIENTIFIC COMMUNITY AND PUBLIC HEALTH ACTORS? A DYNAMIC PERSPECTIVE MINIMIZING SOCIETAL IMPACTS

Minimizing the societal impact inevitably leads to making trade-offs between various components and choices on how to allocate the resources to different societal functions. The trade-offs include, for instance, health and wealth, individual freedom and collective duty, child access to education and senior outdoor access, medical and non-essential activities, international market losses and long-term tax increases, and all of the multiple combinations of these items. This situation corresponds to an economic dynamic optimization problem under constraint in an uncertain and moving environment (14). The economic term is, of course, to be understood in its primary sense of resource allocation and wealth sharing and is not limited to its monetary

component. Hence, the relevant question is how to design the best policy under constraints.

Biological and Economic Constraints

The biological constraints linked to COVID-19 and lockdown-lifting are known and have been extensively studied under various situations (15–19). The constraints arise both from the characteristics of the outbreak (epidemiological parameters, i.e., contagiousness and severity of the disease) and from the structure of the healthcare system (number of available beds, testing facilities, personnel). It is primarily a question of defining the modalities of lockdown-lifting that will not saturate the healthcare system, which would lead to excess mortality due to lack of patient care (19).

In the context of lockdown-lifting and living with an endemic disease, the major economic constraints arise from business resumption and societal benefits. The brutal and general cessation of economic activities has been widely accepted in the case of COVID-19, as was the application of national solidarity for the most affected individuals. However, the prolongation of lockdown leads us to question both the cost-effectiveness of this policy and its acceptability to individuals. A cessation of activity also generates a steep increase in public expenses and simultaneously a decrease in revenue (taxes). This situation leads us to seek a compromise between the resumption of activities and public health. For each resurgence of COVID-19, the issue will re-appear in very similar ways.

The behavior of individuals and their compliance with the potential rules issued for lockdown-lifting represent a major economic component of lockdown-lifting. In the case of selective lift, some people will benefit from population protection, provided in part by the share of the population remaining locked (social benefit) and will also benefit from their private benefits (resumption of activity and freedom of movement). Locked-down people will benefit from protection by being unexposed, as well as from the social benefits derived from the lifting (the contribution to society of the workers), in return for respecting the lockdown. The former would benefit from the positive externality generated by the collective's restrictive measures without having to assume the private costs. However, such free-riding may significantly reduce the effectiveness of the policy, as frequently illustrated in other settings for public good or public health management (20–22).

Biological and Economic Uncertainty

The COVID-19 crisis is an example of management in an uncertain context due to the novelty in biological terms (new virus) and economic terms (large-scale shock). It is not only a question of considering the risk (which is likely) but of uncertainty, which is associated with a higher level of lack of knowledge (we do not know and do not know how to predict). This high degree of uncertainty is often fairly misunderstood (or tolerated) by populations and stakeholders.

SARS-Cov2 is a new pathogenic agent, and therefore there several biological uncertainties exist regarding the detection and care of afflicted individuals and its population dynamics (23). Considerable efforts are underway around the world to strengthen the level of knowledge of its pathophysiology or therapy in order to better treat, cure, predict, and manage the behavior of the epidemic and its consequences on individuals. The fact remains that today, the lifting strategies must be defined with very uncertain parameters. For example, having vaccines available to a large population in the short term would allow for significantly different strategies than if the vaccine were only available on the shelf several years from now.

In parallel with biological uncertainties, at least two major economic uncertainties are identified. The first uncertainty relates to the costs and benefits of lockdown-lifting strategies and medium-term endemic COVID-19 management, which directly depend on the uncertainties of the economic impact of lockdown. The impact could be more or less significant depending on the type of shock that COVID-19 will represent (24). The negative economic impacts could be offset over a post-crisis period, with these benefits even potentially exceeding the losses, but these scenarios seem unlikely, given the intensity and globality of the crisis. The brutal, severe, and global cessation of economic activities suggests a major economic impact, at least in the mid-term, with pre-crisis activity levels not reached, at best, until 2021 (25).

The second economic uncertainty consists of the resilience of our social-ecological system and the possibility of renewal of our lifestyles. Interestingly, some western countries call for an exit from the present COVID-19 situation through an in-depth change of our societal growth model. As part of lockdown-lifting decision-making, it seems reasonable to target a hypothesis of a return to a "before pandemic" state, since this represents in the short term the main way to limit the impact of the crisis. It is moreover in these terms that the majority of economic impacts are measured to date, at least for 2020 (fall in GDP, tax revenues, etc.). Grounding the lockdown-lifting strategy on the current economic system does not exclude the development of alternative economic models in the long term.

TOWARD A HOLISTIC APPROACH OF POPULATION HEALTH FOR THE COVID-19 CRISIS: THE FOUR PRINCIPLES

We propose to apply four main principles in the short and medium terms to manage COVID-19 lockdown-lifting and the following endemic disease situation. Importantly, these four principles focus on short-term policymaking based on available information and use real-time forecasts to adjust the strategies in the midterm. As for medicine, the rationale is to establish an evidence-based policy intervention following a diagnostic relying on a systemic evaluation of a set of information (observations, data, tests, previous knowledge).

Principle 1: Integrate Multiple and Heterogeneous Information to Diagnose and Act With Accuracy

There is an exponentially increasing amount of information available on the COVID-19 situation. The critical information required for rational decision-making is as yet still limited, and

fake news and misinformation propagated massively via social networks blur evidence regarding public health management. There are major concerns about how to make quick decisions that combine up-to-date information. The limited rationality principles suggest the adoption of a procedural rationality approach, i.e., focusing on the process of how to make the best decision with an exponential availability of information rather than on trying to gather all the information, regarding its precision and relevance less. To address the paradox between data availability and its use in decision-making, multi-criterion analysis helps to gather data with various origins and combine information of different natures. It concatenates indicators and considers historical features, actor behavior, and expert opinions.

The integration of various information and metrics for an improved decision-making process may dramatically help to reach optimal societal benefits through balanced and equitable decisions. Epidemiological and economic modeling provide a set of highly valuable sources of information to consider in the holistic decision-making process. The holistic approach proposed and focusing on procedural rationality instead of substantial rationality are required all the more given that all the processes take place in a context of high uncertainty.

Principle 2: Navigate With Uncertain Information, and Communicate It to the Population

COVID-19 requires that decisions be made under uncertainty, as we cannot predict the odds of some epidemiologic, economic, or political events occurring. For instance, it means implementing lockdown-lifting with neither precise information on the seroprevalence in the population and the distribution of seropositive individuals within the different subpopulations at risk (infants, adults, seniors…) nor on the location of contagious people. The nature of the contacts and the observance of biosecurity measures are complex and inconstant. People's behavior is changing (as the system changes), and the resilience of the economic system is not known. Computer simulations must be taken into account, as regular updates will provide new information improving the strategies adopted, but they also face uncertainty.

Uncertainty leads to dynamic adjustments of the decision, and the best decision today may not be the best tomorrow. This means that the decision process is based on biased information and that we must be clear on this within the communication strategy. Political path dependency, i.e., the tendency to keep the same policy, even if not really well-adapted anymore, so as to avoid any criticism on initial lack of vision, should clearly be avoided here, and the dynamics in political decisions should be highlighted and claimed as positive.

Principle 3: Adjust the Strategies Dynamically

A feedback mechanism of the effectiveness of the measures taken allows us to continuously adjust the biological and economic dynamics and therefore represents a fine and precise regulatory tool if used and understood as such. Many metrics can be used

for feedback. In animal medicine, feedback has been applied with success for decades for population health-related decision making. It is based, for instance, on clinical observations and on advanced health indicators provided by production and health data analyzed using machine learning tools (26). In the case of COVID-19, it would be a question of checking on a regular basis whether the predicted event really occurs and whether the trajectory is respected or deviated from. A comparison with the forecasts associated with the containment strategy would enable policymakers to relax or tighten certain rules. Unfortunately, the use of feedback in the management of the epidemic is often limited. On the one hand, the information used must be sufficiently reliable to support the decision, which is generally the case for the prevalence criteria, at least in the hospital system. On the other hand, the adjustment of the measures implemented in the management of outbreaks contradicts the path-dependence of the previous decision, to which policies are particularly sensitive, and requires a significant educational effort to be accepted.

Using the feedback principle for the COVID-19 situation appears a promising approach combining pragmatism and efficiency that will enable a precision health management approach at the local level (town, department) in accordance and complementarity with national rules. The success of its application in animal health population medicine can be duplicated for COVID-19.

Principle 4: Manage Clusters With a Multi-Scalar Spatialized Policy

A multi-scalar policy of lockdown-lifting and endemic COVID-19 management will differentiate the strategies to be implemented as a function of the subpopulations and the ecosystem in which they live. Multi-scalar means well-integrated and coordinated multilevel policies. These principles are well-integrated into the epidemiological approaches of COVID-19 but not yet in the economic ones, whether it be the behavior of actors or their contributions to the creation of wealth.

This differentiated approach by cluster not only improves the performance of the policies for limiting the spread of the disease but it also integrates the interest, for individuals and groups, in unlocking certain populations gradually (27). Clustering allows the inclusion of equity instead of equality. Because collective and superior interest should prevail, applying equity means defining precise rules accounting for all subpopulations' well-being, the contributions of individuals to the collective value creation, and individual constraints at both the personal or familial and professional point of view. Seniors and the unemployed should have access to public areas, respecting given restrictions. Priority for freedom of circulation should remain for medical staff and their support as well as essential sectors. People performing partial home working without any drop in productivity should continue to do so in spite of some preferring to work only at the office. On the contrary, people with a low socio-professional level and no possibility of working at home should be authorized to contribute whatever they can to global societal value. Combining epidemiological clustering

with outbreak management and economic clustering though the contribution of socio-professional groups to societal value may help to achieve the best societal benefit.

In the context of COVID-19, coupling the principle of feedback to a multi-scalar approach, at least with a segmented geographic approach, would make it possible to respond efficiently, and clarifying a precision approach—differentiated geographically and by population—would be facilitated.

IMPLICATION: OPERATIONAL FRAMEWORK FOR EVIDENCE-BASED POLICY INTERVENTIONS FOR COVID-19

Because lockdown has increased social pressure, there might be strong protests against the different strategies to be adopted, all the more so the longer the lockdown and crisis last. Avoiding a political shock is a key point for policymakers but also for overall societal benefit. A "yellow-vest"-like crisis during COVID-19 management may have dramatic consequences. Considering the constraints encountered and the principles described above, we propose an evidence-based policy framework to handle the COVID-19 situation, as is applied to perform medical diagnostics for diseased patients (**Figure 1**). Any policy should envision (i) respecting an equilibrium among the three dimensions

detailed below (public health, economics, and wellbeing), (ii) quantitatively, qualitatively, and continuously monitoring the societal-economic-epidemiological dynamics, allowing (iii) the policy to be adjusted by tightening or loosening measures before the epidemic damage may (re-)occur. The figure represents three successive policies implemented according to the proposed framework.

The framework includes scientific background from epidemiological and economic modeling readily available (blue boxes, **Figure 1**). The epidemiological transmission models used should consider the sub-populations in terms of biological risk (children, adults, seniors) as well as in terms of economic (socio-professional profiles) and political (socially vulnerable populations) impact. Epidemiological and bio-economic modeling are not a substitute for managing uncertainty, but they provide practical support for the expected results of each strategy, which can then be integrated into the overall decision-making process. A well-integrated and coordinated multilevel policy will differentiate the strategies to be implemented as a function of the subpopulations and their social-ecological system. Considering the subpopulations allows societal dimension of the issue to be practically accounted for (**Figure 1**), i.e., accounting for socio-professional categories (for their contribution to the collective production and their vulnerability), hard-to-reach populations (refugees, homeless, high precarious…),

FIGURE 1 | Framework for an evidence-based policy intervention for COVID-19. The central rectangle represents the successive evidence-based policies for COVID-19, supported by *ex-ante* epidemiological and economic modeling. The policy accounts for economic, societal, and public health dimensions (left) for each subpopulation (bubble), which are infants, adults, seniors, and the different socio-professional groups. Feedback mechanisms, based on surveillance indicators, help to precisely and promptly monitor and adjust the policy.

and long-term consequences (child and student education, reintegration of the unemployed...). Considering several social gradients guarantees a precision approach. A high-precision geographically differentiated strategy is possible, providing a high level of coordination of decision-makers within and between geographical areas.

Based on bio-economic modeling, an evidence-based policy can be implemented through the societal, economic, and public health dimensions, differently for various subpopulations. Importantly, the policy is not only the compromise of the monetary and public health dimensions but accounts for societal outcomes as well. Societal indicators refer to strategies that specifically consider non-active subpopulations, or subpopulations that do not directly contribute to monetary value production (GDP). The sub-population epidemiological modeling allows the strategy to be adjusted for minorities as well as for people with specific risk factors. Because COVID-19 is likely to become endemic, these social and societal well-being criteria (non-monetary economic) are key criteria to be accounted for. Policy 1 represents, for instance, a highly intensive level of lockdown (i.e., strict lockdown, as observed in many countries) that leads to strong negative economic and societal impacts by enhancing the public health dimension.

The feedback system guides a practical approach to manage uncertainty. A set of quantitative and qualitative indicators are proposed to precisely monitor the societal-economic-epidemiological dynamics (**Figure 1**, right par). It could, for instance, be based on active surveillance devices (tracking time or location depending on socio-professional profiles) implemented for alternate access to public areas for various populations at risk. Social criteria metrics such as real outdoor access could be used (i) to control abuses and to predict epidemiological metrics for the next week but also (ii) to evaluate how a well-being measure (outside access for the elderly, for instance) is

welcome and adopted (policy evaluation). Such metrics help in measuring the needs and behaviors of the population and adapting the strategy. Epidemiological criteria such as mortality, morbidity, and the possible saturation rates of hospital and intensive care services could be used. The feedback overtakes the regular updating of the bioeconomics and epidemiological models that support decision-making and clearly and directly bridges the gap between the situation in the field and the situation as seen by policymakers. The early balancing process allows tightening or loosening measures before the epidemic damage (re-)occurs. Applying the feedback principle leads, for instance, to changing policy 1 into policy 2 at time 2 to balance the three dimensions and give room to breathe to economics and the locked-down population; for example, the surveillance indicators might show that policy 1 was efficient for outbreak control (decrease in morbidity and mortality and healthcare services no longer saturated), but that social (mental health, acceptability of the lockdown principle) and economic (bankruptcy, GDP decrease) indicators had reached a critical level. A few weeks later, a policy adjustment (policy 3) may occur, due to an increase in mortality and morbidity and a high level of healthcare service saturation), leading to limits being placed on outdoor access for populations with low contributions to the country's economic life (seniors, the unemployed, children), through a spatial-temporal sharing of public areas.

Altogether, this allows an evidence-based policy that steers the strategy with precision and avoids any political shock. Adapting the framework regionally would likely improve the efficiency of such a precision approach.

AUTHOR CONTRIBUTIONS

DR and GL conceived and wrote the paper and the figure. DR and GL contributed equally to the article, and approved the submitted version.

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Developing and Maintaining Public Trust During and Post-COVID-19: Can We Apply a Model Developed for Responding to Food Scares?

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Trust in public health officials and the information they provide is essential for the public uptake of preventative strategies to reduce the transmission of COVID-19. This paper discusses how a model for developing and maintaining trust in public health officials during food safety incidents and scandals might be applied to pandemic management. The model identifies ten strategies to be considered, including: transparency; development of protocols and procedures; credibility; proactivity; putting the public first; collaborating with stakeholders; consistency; education of stakeholders and the public; building your reputation; and keeping your promises. While pandemic management differs insofar as the responsibility lies with the public rather than identifiable regulatory bodies, and governments must weigh competing risks in creating policy, we conclude that many of the strategies identified in our trust model can be successfully applied to the maintenance of trust in public health officials prior to, during, and after pandemics.

Keywords: trust, COVID-19, pandemic management, prevention, risk communication

INTRODUCTION

The effectiveness of public health interventions is dependent on the behaviors of members of the public. Central to our argument is the premise that public trust in public health officials, their messages, and the science upon which their messaging is based, contributes to the success of public health interventions (1). In the context of COVID-19, trust in public health countermeasures is particularly important at the outset of epidemics when the public has limited knowledge about the infection and must rely on official advice, and when vaccines are not yet available (2–4). Further, the abundance of messaging and misinformation available makes it critical that credible sources, such as public health messaging, are trusted in order to counter mis- and disinformation that may be harmful (5). Indeed, the willingness to adopt preventative measures has been found to be greater when people trust government and public health officials (3). For example, trust in medical authorities has been identified as a predictor of vaccination behavior and has been shown to influence perceptions of the effectiveness of protective measures (6–8). Furthermore, trust in government has been associated with adherence to recommended protective behaviors and the intention to accept vaccination regardless of what authorities actually did to manage the risk of

infection (4–6, 9). In this way, public trust is an important matter for public health efforts that seek to rapidly mobilize desirable self-protective behaviors across a population in order to reduce the spread of infectious disease and protect vulnerable populations (10–13). This recognizes that rather than being passive or neutral receivers of public health advice, the public function as active constructors of risk, and may construct risk in ways that might be perceived as irrational or ignorant by public health officials (14, 15). Public trust in government and public health authorities has an important influence over public constructions of risk and their responses to the threat of infectious disease through promoting acceptance of health information (2, 16, 17). The maintenance of the credibility of, and consequent trust in, government and public health officials as an information source is therefore, an important consideration in pandemic management.

Given the need to mount a rapid public response to counter the spread of SARS-CoV-2 and resultant coronavirus disease (COVID-19), it is not surprising that there has been a surge in calls to enhance trust in governments and health authorities (18, 19), reflecting similar calls for a greater focus on trust following the 2009 H1N1 pandemic (20–22). In reviewing such claims however, what exactly is meant by "trust" is not always clear. A conceptually useful definition of trust is "a particular level of subjective probability with which an agent [the public] assesses that another agent or group of agents will perform a particular action and in a context which affects his own action" [(23), p. 217]. Calnan and Rowe argue that the truster must have positive expectations regarding the competence of the trustee, and must regard the trustee as being concerned about, and willing to act in, the best interest of the trustee for trust to be possible (24). Critical then, in terms of fostering trust, is the need for health officials to be viewed as the experts whose intentions and actions are in the best interest of the public.

In 2016, we developed a model for maintaining and regaining trust in the food regulatory system during and after food safety incidents or scandals (25). This model was developed through a two-phase research project. The first phase involved 105 interviews with key stakeholders (food regulators, food industry representatives, and media actors) across three countries (Australia, New Zealand, and the United Kingdom). Analysis of the data resulted in the identification of ten strategies which can be used by food regulators, industry and the media to maintain and regain public trust in the food system. These strategies include: transparency; development of protocols and procedures; credibility; proactivity; put the public first; collaborate with stakeholders; consistency; education of stakeholders and the public; build your reputation; and keep your promises (25). The strategies were member-tested in phase two of the study which used an electronic survey to seek agreement with and rank the strategies identified by stakeholders (25). In a subsequent study these strategies were tested with and ranked by a representative sample of the public, with high congruence between the original model and strategies suggested and ranked by the public (26).

In the discussion that follows we define each strategy and explore its applicability to the building and maintenance of trust in public health officials during pandemics drawing upon accounts of pandemic management in the academic literature and current events. We then outline some issues to consider in applying this model to pandemic management noting the ways in which pandemic management differs from the management of food safety incidents and scandals. Our aim is to demonstrate how strategies identified in the model can be applied to trust maintenance during pandemic crises.

APPLYING A MODEL FOR DEVELOPING AND MAINTAINING PUBLIC TRUST TO PANDEMIC MANAGEMENT

The model identified ten strategies for maintaining and building trust in food regulation that may be adapted as a means of developing or maintaining public trust in and compliance with public health risk mitigation strategies. Transparency was the ranked as the most important strategy in maintaining trust by both key stakeholders and the public, which follows the emphasis on transparency or openness as trust-building strategies during periods of pandemic (27–29). Transparency in this context was understood as providing timely information about level of risk, communicating openly, timely and honestly with the public, substantiating claims, openness about what can be investigated and accountability when things go wrong (25). This is particularly important where difficult and disruptive actions (e.g., social distancing, closure of small businesses, postponement of non-essential medical procedures) are likely to generate controversy and strong emotional responses from the public (30), raising questions of whether risk assessment and mitigation strategies communicated by government and public health authorities should be trusted, and therefore enacted. It is important therefore, that the public receive timely and accurate information about current disease status and future disease projections as this information is essential for making sense of the level of personal risk and demonstrates the effectiveness of public health strategies (14). There is also likely to be greater compliance with precautions such as social distancing if the public understand the rationale for these strategies and have a realistic understanding of the time taken to develop other more comprehensive solutions such as vaccine development for COVID-19 (31). Maintaining transparency regarding scientific uncertainty has also been identified as an important strategy for maintaining trust within the pandemic literature (32, 33), with Holmes asserting that "scientific knowledge is always provisional and uncertain, and it will be at its most uncertain during a suspected emerging infectious disease, as new information and theories surface daily. To retain trust, spokespeople must acknowledge what they do not know" [(32), p. 356].

The development of protocols and procedures was also considered to be an important strategy for trust maintenance by both stakeholders and the public. This involves the development of crisis plans and ongoing surveillance of risk (25). Globalization and subsequent difficulties in containing infectious disease within national boundaries have contributed to ongoing preparations for an influenza pandemic by international organizations including the European Center for Disease

Prevention and Control and the World Health Organization (WHO) (34, 35). The WHO adopted a governance model that involved ceding national sovereignty over public health policy to the international community and establishment of pandemic phases, although the WHO's June 2013 interim guidelines allowed for greater national flexibility in response (36). The *Australian Health Management Plan for Pandemic Influenza* is for example, based upon four phases: preparation (e.g., establishing relationships, monitoring; ensuring resources are available for rapid response); standby (e.g., communication to raise public awareness); action (e.g., health care and public health responses) and stand-down (e.g., resumption of previous activities and monitoring) (37). Legido-Quigley et al. identify eight actions taken by countries successfully managing COVID-19. These are: travel restrictions and quarantine for travelers; development of surveillance systems to test the public and trace contacts; intergovernmental co-ordination; public assistance for medical costs associated with the virus; strategies to sustain existing health services; obtaining crucial care equipment, medicines and personal protective equipment; adherence with infection control practices by health services; and management of information systems to promote information sharing (38).

Credibility as a strategy was also rated highly by stakeholders and was primarily associated with the independence of medical experts from government, what has been referred to as "epistemic authority" (39). Declining trust in public institutions has enabled the proliferation of alternative sources of information leading to potential for misinformation (5). In the United States, for example, partisan news reporting by Fox News contributed to rejection of Centers of Disease Control recommendations (40). Goldstein argues that when unpalatable public health messages need to be communicated they are better received if the message is delivered by agencies which are "independent of the organizations or individuals for whom the truths are inconvenient." [(41), p. e13]. Following the 2009 H1N1 (swine flu) pandemic there was evidence of an observed decline in public trust in medical organizations, the government, the World Health Organization, and pharmaceutical industry in Switzerland (42). This is reflective of a broader "crisis of public trust" (20, 43) following the H1N1 pandemic where the public has become more skeptical of the real risk posed, and suspicion of hidden agendas amongst health organizations and the pharmaceutical industry (2, 17). Independence is particularly important in regions where other events (e.g., social unrest in Hong Kong) have eroded trust in government (38).

A fourth strategy is being proactive. Proactivity is associated with regular review and updating of public health advice and recommended practices as new evidence emerges during the pandemic, and prompt communication about emerging issues (25). Proactivity is related to transparency through timely information sharing, release of data set and modeling, and to the development of protocols and procedures through regular review and updating of procedures. However, maintaining proactivity in pandemic preparedness and response should be assessed against the potential risks of raising false alarms, which have been shown

to contribute to a public skepticism of the real risks posed by pandemics and an erosion of trust in governments and public health (20, 44).

A fifth consideration in the model is putting the public first. Our model argues for prioritizing the public but notes that while the health and safety of the public was given high priority, agreement on the importance placed upon public values (e.g., food regulation concerns with food additives or genetically modified food) were given lower priority (25). The public's health and safety is paramount to pandemic management, but, unlike food regulation, successful management only occurs if a critical mass adopts the recommended behavioral strategies (9) such as handwashing and social distancing to reduce spreading. As such, pandemic management operates at a population level rather than at the level of individual members of public and trust that officials are acting in the interests of the public is likely to increase compliance.

Education of stakeholders and the public was also identified as important for maintaining trust in food regulation (25). Education occurs through provision of timely information in accessible formats for the public. Siegrist and Zinn identify gaps in knowledge and misconceptions about vaccination and herd immunity which are further compounded by the public needing to decide between competing information sources (45). Likewise, 77% of Republicans in recent research undertaken in the United States, believed that the media exaggerated the risks of COVID-19 (40). Trust in incorrect information or even conspiracy theories (46) may prevent adoption of preventative strategies (47, 48) and can be addressed through targeted social marketing campaigns.

It is also vital to ensure that the needs of different population groups are identified and these different groups are communicated with in ways that meet their needs. Factors (including those that are health-related) will affect how individuals and population sub-groups respond to public health communications and how willing or able they are to enact communicated risk-mitigation strategies. Identifying the needs of different population groups, and ideal ways to communicate with them in order to maximize compliance with government public health messages, is paramount and further research is needed in the context of COVID-19 (11, 30). In the context of COVID-19, this is especially relevant given that there are certain groups for example older people and those with chronic conditions, who are greater risk of experiencing complications when contracting the virus (49). Hence specific communication strategies to target these people must be developed. Hence specific communication strategies to target these people must be developed. For example, following the 2009 H1N1 pandemic in New Zealand, members of vulnerable populations expressed a need for governments and health officials to communicate specific actions that they could take to protect themselves and their families from infection, suggesting that public values of self-protection were driving behavior change amongst vulnerable groups (22). In considering the public, trust-enhancing activities must be cognizant of and respond to such public values.

Collaboration with stakeholders was identified as a further strategy to improving trust in food regulation. The primary

stakeholders for food regulation are the food industry and the media which disseminates information about food safety incidents or scandals and are instrumental in building or diminishing public trust in food governance (25). The media is also an important stakeholder in pandemic management. Trust in media has also been found to be positively associated with willingness to adopt preventative measures (9). An example of the effects of such collaborative work can be found in the Chinese response to 2013 H7N9 epidemic, in which the Chinese state and media organizations worked together to provide daily updates regarding the epidemic and appropriate preventative measures (alongside the suppression of misinformation), functioning to reduce rises in social anxiety during the epidemic (50). General practitioners and other health professionals are also important stakeholders as the public often trust information received from health professionals over that received through public health campaigns (6) or other community sources (51). The government, particularly those government officials involved in disseminating public health advice, are also vital stakeholders given the way in which trust might be built or eroded depending on the conduct of these communicators (52). Governments and public health officials produce pandemic response plans which guide government action and communication to the public. Building relationships and ensuring that these groups receive timely and appropriate information may therefore, increase uptake of preventative behaviors and vaccines through ensuring consistency in messaging.

The final strategies: "build your reputation"; and "keep your promises" primarily relate to action taken between food safety incidents or scandals (25). One of the key findings from our earlier study was that trust in the food system depends on actions by food regulators between as well as during food safety incidents. The study identified communication strategies which can be used to increase awareness of, and build the reputation of regulators. These may include: fostering relationships with the media to promote rapid dissemination of information; the use of social media including twitter to promote the work of the regulators; and establishment of public committees (53). Building trust is also important before a pandemic as trust in health governance has been positively associated with uptake of behavioral recommendations (6, 9). Effective performance in management of other public health issues may increase trust in health governance prior to pandemics. Other factors important for ensuring good trust exists between the public and the government prior to pandemics are the presence of pandemic response plans and maintaining good trust during "business as usual," or proactive communication.

ISSUES TO CONSIDER IN APPLYING THE TRUST MODEL

In the following sections, we identify issues to consider when applying the trust model to the context of COVID-19. These include ways in which pandemic management differs from food safety but also issues reacted to governance. In order to support the adaption of a model of trust-building strategies relevant to

food crises to trust-building in the context of epidemics and pandemics (as crises of infectious disease), there needs to be an explicit examination of assumptions made about the concept of trust and the socio-political context of trust.

In Who Do we Trust?

Food regulation differs from management of pandemics as food regulation is an ongoing process with an identifiable body that is responsible for food safety with established protocols for communication of information. During pandemics, responsibility for management falls to government working in consort with public health officials and the health professions. Within the pandemic-trust literature, this has contributed to a focus on trust in government (42, 50, 51), healthcare industry (42), public health organizations (6, 42, 54, 55), communicators of public health messages (22, 52, 56), and the communicated messages themselves (57). Effective pandemic management has been associated with "agreed communication strategies, [a] clear division of responsibilities" and agreed policy guidelines (35, p. 21). Difficulties can arise when/if contradictory messages are received from key players. This has been the case during the current COVID-19 pandemic in the United States. Survey research conducted in the US in February 2020 found that 69% of participants favored public health leadership (either Centers for Disease Control or National Institutes for Health) over political leadership of the pandemic response (19). The domination by the US President of daily updates and provision of information which is contrary to public health has eroded public trust in government (58). A recent poll found that both Democrats and Republicans express diminishing trust in the President with only 23% of respondents expressing high levels of trust in COVID-19 information given by the President (58). This contrasts with the Australian experience where a high proportion of Australians rate the Government's response favorably (59).

Impact of Risk Perception

Perception of the risks posed by a pandemic has been identified as an important motivator for continued compliance with preventative measures after the initial phase of the illness (4, 60). Yet information about disease risk during pandemics is often provisional or ambiguous (13, 20, 30). Processes such as social isolation and social distancing in contrast, are associated with identifiable economic risk both for the country and for the individual. Competing risks must be balanced by government in lifting restrictions. Brown argues that this decision is often informed by political ideology rather than public health. He argues that "governments following distinctively right-leaning, economically liberal, socially conservative and individualizing policy trajectories" are more likely to adopt conservative management strategies but acknowledges that this may reflect cultural norms which promote suspicion of public intervention in the private sphere [(14), p. 3]. Regardless of underlying cause there is evidence that countries that were slow to initiate preventive measures and/or quick to remove restrictions (e.g., United Kingdom, United States, Brazil) or that introduced minimal restrictions (e.g., Sweden) have experienced higher rates of morbidity and mortality (61). Further, given that a critical mass

is required for effective pandemic management, the options for individual management of risk are reduced in these settings.

Federalism and Fragmentation

In contrast to food regulation where relationships between government are formalized, further issues may arise when co-operation across multiple levels of government, either across or within nations, occurs. Different levels of government may have different agendas with competing agendas requiring the public to choose which level of government to trust. Federalism has been associated with duplication of services, difficulties in identifying who is responsible, gaps in service delivery and shifting of responsibility across levels of government (62). In Australia for example, the provision of health care services lies with state governments, while the Commonwealth government provides financial support for community and residential aged care services, and general practice which are predominantly privately owned (63). The Commonwealth government uses financial support to influence policy and practice in both aged care and primary health. During the COVID-19 pandemic for example, the Commonwealth government successfully used this power to leverage the Communicable Diseases Network Australia restrictions to protect the elderly in Residential Aged Care in the aged care industry (64). It has been supported by state governments in this. In other situations, however there have been disparities between Commonwealth recommendations and state restrictions based on assessment of the level of risk within a given state. For example, the Commonwealth has sought to use funding to encourage the earlier opening of private schools, which has been in contrast to public schools funded by State Governments who desired a longer shut-down period. This can result in public confusion and frustration if advice and actions are different. Further, local governments (councils) in two Australian states (Victoria and South Australia) have a legislative responsibility for public health creating a third level of governance (65). This can all impact on public trust because it brings complexity and uncertainty into play.

Tailoring Public Health Messages

Brown notes that both health literacy and level of trust in public health officials vary according to social characteristics, leading to sub-groups who are more or less receptive to public health messages. He argues that it is "vital that we pay attention to different sub-groups in political systems, and acknowledge how varying experiences and perceptions of government and healthcare organizations, shaped at the intersections of class, gender, race and ethnicity, will shape very different relations and approaches to risk" ((14), p. 3). These groups may require different forms of communication to overcome negative perceptions of health organizations and their recommendations. Gray et al. found for example, that Pacific Islander peoples were more likely to trust information about H1N1 management received from community rather than other more official sources. They conclude that trust must be considered in tailoring health messages (22). There is also evidence from previous epidemics, that some population groups

place greater trust in informal sources of information (such as social media) rather than formal sources such as public health organizations, resulting in greater levels of worry (16). Therefore, public health officials must consider whom they are communicating with and ensure that trust is formed with all members of the public.

Personal Responsibility vs. Enforcement

A point of difference between pandemic management and food regulation is that failure to follow public health directives has implications beyond the individual and their immediate families. As such, there is greater legal and moral regulation of public health behaviors. Police in Australia have been given a range of powers to protect state boundaries; ensure restrictions on public gatherings; to enforce quarantine for people returning from overseas or who have been diagnosed with or in contact with someone diagnosed with COVID-19; to enforce closure of non-essential businesses and to limit access to residential aged care facilities (66). The extent to which legal enforcement is responsible for compliance with public health directives and how much is driven by trust in public health officials and information is unclear, although past epidemic literature suggests that the punitive measures are likely to play a role (50).

In contrast to these coercive approaches, behavior change may also be achieved through a form of public self-governance created through the moralization of public behavior. An example of this was described by researchers in Hong Kong, who found that appealing to nurses' moral responsibility to patients was effective in increasing uptake of influenza vaccinations (67). Conversely, moral discourses can be used as the basis for rejecting public health messages. Protesters against restrictions associated with COVID-19 in the United States and United Kingdom have drawn upon libertarian discourses of individual and religious freedoms from state interference to challenge ongoing restrictions (68). An alternative moral discourse, drawing on concerns for vulnerable members of our community, could counter this libertarian opposition to public health intervention.

CONCLUSION

In this paper, we have highlighted the need to undertake research about global pandemics, specifically, the relationship between government action, public trust and public health behavior in the context of COVID-19. We applied our model, previously developed in the context of food safety incidents and scandals, to highlight some strategies that may apply to communicating effectively with the public around COVID-19 and public health behaviors that are required for the ongoing good health of the public. There are differences between food safety and pandemic management related to the ongoing role of food regulatory organizations in relationship development and establishment of communication strategies. Further, pandemic management requires widespread community rather than individual compliance for success. We emphasize that any research in risk mitigation and risk communication

needs to be undertaken in different population groups because of the different needs different groups may have in terms of communication strategies, taking into account the actors involved, type of risks, and socio-political context of a pandemic response. Such research is important to ensure that public trust in the government and public health officials is maintained, government advice is followed, and the health of the public is maximized during current and future pandemics.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

AUTHOR CONTRIBUTIONS

JH wrote the first draft of the paper and all authors provided a written contribution and approved the final version. AW, PW, JC, ET, DM, SM, and TW were involved in the development of the Model referred to in this paper. HP reviewed the literature used in this paper. AW provided leadership to the team. All authors contributed to the ideas explored in the paper.

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The Role of Experts in the Covid-19 Pandemic and the Limits of Their Epistemic Authority in Democracy

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In the 2020 Covid-19 pandemic, medical experts (virologists, epidemiologists, public health scholars, and statisticians alike) have become instrumental in suggesting policies to counteract the spread of coronavirus. Given the dangerousness and the extent of the contagion, almost no one has questioned the suggestions that these experts have advised policymakers to implement. Quite often the latter explicitly sought experts' advice and justified unpopular measures (e.g., restricting people's freedom of movement) by referring to the epistemic authority attributed to experts. The main goal of this paper is to analyze the basis of this epistemic authority and the reasons why in this case it has not been challenged, contrary to the widespread tendency to devalue expertise that has been observed in recent years. In addition, in relation to the fact that experts' recommendations are generally technical and supposedly neutral, we note that in the COVID-19 crisis different experts have suggested different public health policies. We consider the British case of herd immunity and the US case of the exclusion of disabled people from medical care. These decisions have strong axiological implications and affect people profoundly in very sensitive domains. Another goal is, therefore, to argue that in such cases experts should justify their recommendations-which effectively become obligations-by the canons of public reason within the political process because when values are involved it is no longer just a matter of finding the "best technical solution," but also of making discretionary choices that affect citizens and that cannot be imposed solely on the basis of epistemic authority.

Keywords: SARS-CoV-2, public health, political process, expertise, herd immunity, disabled people

INTRODUCTION: EXPERTS AND THE COVID-19 PANDEMIC

A case of coronavirus (SARS-CoV-2) causing severe acute respiratory syndrome (SARS) was first (officially) identified in the Chinese city of Wuhan, Hubei Province, in December 2019. The virus can be transmitted between people who are in proximity to one another and via respiratory droplets produced when an infected patient coughs or sneezes. The virus is also transmitted when someone touches an object with the virus on it. The outbreak initially spread mostly within mainland China. On February 12, 2020, the World Health Organization (WHO) officially named the disease caused by the novel coronavirus as Coronavirus Disease 2019 (Covid-19). By the end of February 2020, Covid-19 had infected more than 75,000 people. During the next months, new major epidemic foci of Covid-19 were identified and started to rapidly grow in Asia (especially in India), in Europe (especially in Italy, United Kingdom, Spain, France, and Germany), in North America

(especially in the US), and in the Middle East (especially in Iran and Saudi Arabia), with an increasing number of confirmed cases in Latin America (especially in Brazil). Based on these alarming levels of spread and severity, on March 11th 2020 the World Health Organization described the Covid-19 situation as a pandemic. As of July 2020, more than 10 million cases of Covid-19 were reported resulting in about 500,000 deaths[1].

As the emergency worsened, it became clear that the leaders of many countries initially underestimated the severity of the pandemic. In the first few weeks, there was a notable lack of information characterized by the inability or unwillingness to provide precise information about the spread of the virus on the part of several governmental agencies. For instance, China hid and censored the reports released by the doctors, who first became aware of the spread of a dangerous new virus. In this case, what was at play was the political will not to frighten the population and avoid economic repercussions, especially on exports, in a city like Wuhan, home to important manufacturing companies that have strong trade relations with the whole world[2]. Secondly, those in power showed general unpreparedness to manage the crisis, once the pandemic could no longer be denied or hidden.

In addition to the will of not inducing panic or creating economic hardship, the concern of some state authorities was to show that they were in full control of the situation by not having to introduce extraordinary measures, which are a sign of a lack of preventive interventions or ineffective ordinary containment. This has caused many affected countries to fall short of delivering unambiguous advice on when and how to limit gatherings, cancel big events, postpone travel, or reduce industrial production and trade, which contributed substantially to the spread of the infection. For example, Donald Trump's dismissed the pandemic as a "Democratic 'hoax,'" predicting that it would disappear like a miracle. Likewise, the Brazilian president Jair Bolsonaro characterized the coronavirus pandemic as a media-fueled "fantasy." More generally, many politicians have consistently engaged in a dangerous game of reality-denial that so far has cost many thousands of lives and is bound to cost more[3].

In the meantime, though, especially in countries where the media are free and able to provide complete information in real-time, the population became aware of the danger posed by Covid-19[4]. Within this framework, medical experts (especially virologists, immunologists, and epidemiologists but also statisticians and public health scholars) have been stepping up. Unlike politicians and decision-makers at various level, who have been offering rather vague and often contradictory advice from the onset of the pandemic, many experts have been warning for weeks that the outbreak could explode and suggested very early to put in place a range of hard measures (including social distancing, closures of schools and universities, bans on large

gatherings and international travels, smart working, and self-confinement) to prevent the virus from spreading further (1, 2).

Thus, for their resolution and proactiveness in the face of the growing number of deaths, experts have quickly gained general appreciation in society and acquired an increasingly central role in counteracting the spread of the disease. Politicians (prime ministers, presidents, ministers, members of parliaments), who at the onset of the pandemic often lacked leadership, started calling upon experts to help devise the best possible strategies to protect society and public health. The media also started giving experts a prominent role, hosting panels of experts in TV debates aimed at informing the public about the causes of the pandemic and the possible preventative measures to be taken in order to avoid contagion. Thus, after realizing the seriousness of the situation, the dangerousness of the disease, and the extent of the contagion, most of the people began trusting experts more than their elected representatives.

In general, though, we can say that the medical field is one of the domains where people rely on experts for decisions concerning their health and safety. Recently, the rejection of vaccines and the popularity of treatments alternative to those recommended by mainstream medicine have gained attention; however, this phenomenon of refusal of mainstream medicine remains rather limited and it is not shared in the wider society (3)[5]. Experts still maintain their epistemic authority among the public in the biomedical field and this epistemic authority is mainly based on the fact that therapies are becoming more and more effective, that some diseases have been eradicated (e.g., smallpox, rinderpest), and that average life expectancy has substantially increased over the last 50 years[6].

In the context of the coronavirus pandemic, most world leaders began appealing to medical experts and to their epistemic authority to justify the implementation of unpopular measures (such as enforced quarantine) considered the most suitable to slow down the spread of Covid-19[7]. This step has been motivated by, at least, two elements. On the one hand, political authorities perceived that their ordinary actions were ineffective and had to make full use of biomedical expertise, often essentially delegating strategies and decisions to experts (e.g., implementing them and resolving any conflicts between different social actors; for example between trade unions and employers, the former being more favorable to closing factories for the workers' safety, the latter more inclined to keep them open for economic reasons). On the other hand, if leaders resort to the epistemic authority of experts, they are prima facie relieved of responsibility for the choices made, especially if they are unwelcome by public opinion, are ineffective, or have unforeseen negative side effects. In reality, this dynamic that leads experts to assume a central role in politics can -as we shall see below- create problems in itself, since the strategies proposed by experts are often far from neutral with respect to the values that a pluralistic society considers relevant. In this paper, we explore

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[1]https://www.worldometers.info/coronavirus/#countries (accessed July 1, 2020).
[2]https://www.bbc.com/news/world-asia-china-51403795 (accessed April 2020).
[3]https://www.youtube.com/watch?v=G5TZ6fTYrsE (accessed April 2020).
[4]https://www.politico.com/news/2020/03/16/coronavirus-pandemic-leadership-131540 (accessed April 2020).

[5]https://www.politico.eu/article/how-anti-vax-went-viral/ (accessed April 2020).
[6]https://www.who.int/vaccine_safety/initiative/detection/immunization_misconceptions/en/ (accessed April 2020).
[7]https://ourworldindata.org/life-expectancy (accessed April 2020).

the ramifications of this idea, which has been overlooked in the relevant literature.

As our study is not an empirical one, we resort to qualitative analysis, which involve two cases, namely the early management of epidemic in the UK, and the limited access to life-saving therapies for disabled people in the US. We present a theoretical framework of experts' epistemic authority and introduce philosophical and normative considerations to try to determine the extent to which the authority of experts should be followed. Crucially, these considerations are based on facts and events that are publicly available but not well-scrutinized so far. Accordingly, the structure of the paper is the following (necessarily different from the classical structure and partition of a quantitative study article).

In section The State of Affairs: Epistemic Authority, Experts, and Their (Controversial) Role, we lay out the basis of our study; that is, we analyze the basis of the experts' epistemic authority and the specific dynamics at stake in the case of the coronavirus pandemic. In section Case Studies: Expert Authority and Non-neutral Assessments, we consider the role of experts' recommendations in society in the light of the two cases we discuss. We show that these recommendations should not automatically become obligations simply because of the experts' epistemic authority; rather, they ought to be discussed thoroughly, based on the canons of public reason within the political process, so as to reach the broadest possible consensus. In section Discussion: What we Can Learn From the Responses to the Pandemic, we consider what we can take home from the two cases analyzed and offer a range of suggestions about the future role of biomedical experts in pandemic situations. We conclude the paper, section Conclusion, by summarizing what we have achieved and by reflecting on the implications of our findings.

THE STATE OF AFFAIRS: EPISTEMIC AUTHORITY, EXPERTS, AND THEIR (CONTROVERSIAL) ROLE

According to Goldman [(4), p. 92]: "[W]e can say that an expert (in the strong sense) in domain D is someone who possesses an extensive fund of knowledge (true belief) and a set of skills or methods for apt and successful deployment of this knowledge to new questions in the domain. Anyone purporting to be a (cognitive) expert in a given domain will claim to have such a fund and set of methods, and will claim to have true answers to the question(s) under dispute because he has applied his fund and his methods to the question(s)." For Goldman, someone is an expert as long as she satisfies two basic properties: (a) she knows a lot about a given topic; (b) she can apply that extensive knowledge of that given topic to other situations, so as to rationally predict their possible outcomes. Goldman's view of expertise is sound and has been very influential; however, it is not the only one available in the literature.

Another account of expertise, one that is perhaps more relevant for the purpose of this paper, was recently developed by Quast (5), who argued that the nature and value of expertise lie in its service-function and social role. According to Quast, expertise is a social kind that not only requires competences,

relevant knowledge and the capacity to apply this knowledge and competences to new situations (as in Goldman's account) but also inevitably requires and demands a special responsibility toward society – a deontic dimension, so to speak. Thus, experts – according to Quast – are people who have knowledge and competences, which they can apply to new scenarios, but who also have a specific mission in society. By virtue of this, experts possess an improved epistemic stance (or greater epistemic authority) over non-experts and can make informed decisions and accurate predictions that can increase the welfare of their communities. Here welfare is understood in the broadest sense of the term, including both knowledge and the material and social living conditions of people (e.g., through improved functioning of political institutions or more inclusive policies).

Yet, what are the specific traits that allow experts to acquire such an improved epistemic stance? In other words, what are the markers of expertise and when can we reasonably say that we can trust someone as an expert? These questions are hard to answer and probably there isn't a clear-cut solution to them. However, we can say that someone can be considered as an expert if she has, at least, a combination of the following traits: (i) motivation and focus; (ii) good education; (iii) solid experience in the field; (iv) significant achievements; (v) excellent reputation among peers; (vi) a prestigious position; and (vii) no personal interest in the issue at stake.

In other words, an expert is a person that typically has a high academic degree (such as a Master's or PhD) from a reputable institution and that has significant experience in their own field. An expert, however, is also a person that has achieved significant results in her field (e.g., publications in leading journals, prizes, fellowships, or grants), that is held in high esteem among her colleagues, and that holds or has held prestigious positions (in important institutions, for instance). But an expert, in order to be trusted, also ought to be a disinterested party, meaning that she must not have any stake in a specific belief. In addition, she must be motivated and focused (6) in her research and not be willing to compromise it for immediate rewards. These are the traits that, jointly taken, can make someone an expert and can warrant them greater epistemic authority (hence trustworthiness) over non-experts. But why do people trust experts?

In general, it can be said that there are three orders of reasons why experts have gained more importance in our lives and in the public arena. The first reason is that resorting to experts actually works: it's a rather successful practice. Average life expectancy got longer thanks to medicine and its steady progress. Life conditions have progressively improved, as well. Many life problems have found a concrete solution, with more goods at people's disposal, more free time, and the possibility to travel.

The second reason is that resorting to experts is a way to curb any potential controversy. Many descriptions of science portray it as a selection/competition between theories aiming at the "true" description of reality or as a process of repeated conjectures and confutations (7); however, the most adequate image is probably that of the inference to the best explanation (8). The inference to the best explanation is a socially non-traumatic procedure aimed at progressively excluding the theories that predict and explain fewer phenomena than other ones: this leads to provisionally consider a given theory as the one with the best explicative

and predictive capacity (9). Still, such theory can be refined, modified or even replaced by a more informative theory, if one is found (10).

The third reason for the experts' crucial role in democratic governments is rather cultural/intellectual. Resorting to experts and their (supposedly) objective knowledge means resorting to rationality – a faculty that, in turn, is elevated to the status of ideal objective for any evolved community, and as such is able to solve problems and controversies objectively.

Yet, being an expert and thus possessing an increased epistemic authority does not automatically warrant credibility in the eyes of laypeople. In recent years we observed a tendency to openly distrust experts and their knowledge (notable case studies involve climate change and Brexit). With respect to the latter, many foreign leaders and moral authorities had repeatedly expressed serious concerns about the possible undesirable consequences of a Brexit. In a similar vein, the UK academic community (including leading economists) consistently and overwhelmingly warned the population of the significant economic costs that leaving the EU would entail for Britain.

Such warnings were largely dismissed, and the UK left the EU on January 31st, 2020[8]. As former secretary of state for justice, Michael Gove put it: "people in this country have had enough of experts" (11). And this pattern is not only confined to the UK. In the US, voters explicitly disregarded the opinion of pundits and in 2016 elected Donald Trump, who, against perhaps 99% of scientific consensus, denies the reality of climate change (12). In France, Marine Le Pen – the leader of the National Front – routinely receives little sympathy from experts but maintains strong popular support. The same can be said for Viktor Orban in Hungary, for Geert Wilders in the Netherlands, or for the far-right coalition that is ruling Poland at the time of writing (13). Thus, it seems safe to say that everywhere, in recent years, there has been a widespread tendency among laypeople to devalue expertise, so that a very great number of people have become extremely hostile to experts.

Although this is not the focus of our article, it is important to underline that there are at least two reasons for this tendency to distrust experts, which nevertheless coexists with the massive use of experts and their knowledge in many private and public sectors[9]. The first reason, linked to the political process, is that some parties and some leaders support programmes and reforms that are based in varying proportions on nationalistic, populist, conservative and religiously inspired ideas (14). All these orientations tend to reject globalization, open economy and society, materialism, secularism, hierarchies of knowledge that exclude citizens from decision-making, progress as a primary objective, the importance of questioning and verifying one's deep-rooted convictions – in short, everything that is or appears to be the legacy of the scientific method and of the direct or indirect

action of experts[10]. Another factor is the systematic exploitation of emotions and visceral responses (15) as a tool to achieve consensus on the part of politicians, which causes a further clash with the method of rational and experimental testing.

The second reason for the criticism of experts, as manifested for example in the anti-vaccination movement, has a different character, as it also affects educated and informed shares of the population in Western democracies (16). This is a fairly recent phenomenon that seems to find its main explanation in the spread of social media, i.e., in the disintermediation of knowledge and the erosion of the authority principle (17). The idea of personal autonomy can also take the form of the rejection of expert opinion as a claim to one's own space of self-determination, even if this implies one's ignorance with regard to the subject matter. In this way, we are witnessing, in some areas of knowledge and in some social contexts, a contestation of the idea of competence and the division between experts and laypeople.

Everyone, in short, has the right and the possibility to document themselves and get their own idea, thanks to easily accessible tools such as Google, and then to spread and defend their view via social media, which are a completely new and very powerful means of knowledge creation from an epistemic and social point of view. There is a claim for equality which, having spread in many other areas, is also supposed to apply in the field of knowledge. The feeling of having been deprived of decision-making power by a small group of competent people with consolidated and apparently inaccessible knowledge – essentially a sense of impotence – often provokes a hostile reaction with respect to the experts' indications, except when they are perceived as a standard and non-controversial procedure (take an analgesic against headaches; buy a fast and powerful computer, etc.) (18).

These two strands of hostility toward experts, while being differently motivated, are united by the fact that rational arguments and well-documented evidence tend not to convince those who support unorthodox positions or contest the scientific mainstream (19). This type of reaction has been attributed to evolutionary psychological mechanisms (which favor the unconscious selection of evidence in favor of one's own beliefs) and to group cohesion, which promotes the maintenance of shared views to strengthen the identity and cooperation of members, while also fostering further exposure to messages in support of the accepted ideas in the so-called "echo chambers" (20).

However, there is evidence that when the subject on which laypeople and experts disagree directly affects people's lives, with varying degrees of threat to which an effective response must be given, then the persuasive force of established expertise and knowledge prevails and is used to a much greater extent. The coronavirus has a short-term direct effect, whereas – for example – climate change affects people's lives but not in the immediate term, so the evidence is dismissed. This is particularly important in the context of the Covid-19 pandemic (21). Now, a critical ingredient for successfully addressing pandemics worldwide is

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[8]https://www.theguardian.com/politics/2015/nov/11/leaving-eu-would-be-a-disaster-british-universities-warn (accessed April 2020).
[9]https://www.project-syndicate.org/commentary/brexit-voters-ignoring-experts-by-jean-pisani-ferry-2016-07?barrier=accesspaylog (accessed April 2020).

[10]There is no value judgment in our analysis. We just want to show the areas of frequent contrast between certain political forces and the proposals made by experts and scientists.

public order and civil obedience to protocols. This means that, for people to respect socially demanding measures (such as enforced quarantine), they need to be offered reliable and credible messages from trusted sources of information. So, intentional disinformation about science is particularly damaging to the credibility of experts seeking to formulate appropriate health policies (consider for instance the anti-vaccination movement) as it inhibits people's trust in experts' advice.

In the COVID-19 pandemic, however, we observed -as discussed above- two stages[11]. The first stage was characterized by concealment of information and institutional disinformation, which contributed to eroding the general public's trust in governments and international institutions (this was largely in line with the tendency observed in recent years)[11]. In the second stage, instead, experts voiced concern for emergency preparedness, protested against budget cuts to essential domestic and global health programs, and begun proposing the implementation of public health measures to help citizens avoid contagion, thereby becoming – once again – sources of accurate information and of reliable health policies (22)[12].

Due to the seriousness of the pandemic and the concrete threat to the population, with the exponential increase in the number of infections and victims observed, most of the population relied on the authority of experts[13]. In a similar vein, nearly all governments – some out of conviction and therefore more quickly, others out of necessity shortly afterwards – made use of technical-scientific committees already active or set up for the occasion, and delegated to them the identification of the most suitable public health policies. In some cases, as we shall see, expert opinions have been divergent or governments have chosen to rely on experts who were more in tune with their general approach, agenda, or public health policy. Overall, this delegation of power and of responsibility to experts has allowed leaders and governments to lighten their own responsibility toward society.

Having discussed the basis of epistemic authority, we next look at the role that experts' recommendations can play in society. We argue that such recommendations -albeit reputable and authoritative- shouldn't be accepted uncritically; rather they always ought to be discussed thoroughly in the political process, in the light of the canons of public reason.

CASE STUDIES: EXPERT AUTHORITY AND NON-NEUTRAL ASSESSMENTS

The epistemic authority of virologists and epidemiologists cannot only be based on the success of biomedical science, as the latter is not an exact discipline. Even if the so-called evidence-based medicine (23) has gained ground, and algorithms are proving to

be better than humans in certain types of diagnoses (24), it is still said that medicine is an art, where personal experience and intuition play a key role, as shown by Dr House in the popular TV series. This requires the epistemic authority of experts to have a more solid basis. This basis seems to be scientific naturalism (25, 26) understood as a conception of reality and knowledge whose core consists of two crucial ideas or tenets:

- at the ontological level, supernatural elements do not exist,
- at the epistemological level, science (or otherwise empirical, intersubjectively reproducible and falsifiable research) is the primary, if not the only source of reliable knowledge.

To consider a famous definition, "[scientific] naturalism is a species of philosophical monism according to which whatever exists or happens is natural in the sense of being susceptible of explanation thorough methods (…) paradigmatically exemplified by the natural sciences" [(27), p. 448]. And these methods and explanations are or should be, strictly empirical. As a consequence, scientific naturalism also implies that "scientific inquiry is, in principle, our only genuine source of knowing or understanding. All other alleged forms of knowledge (e.g., a priori knowledge) or understanding are either illegitimate or are reducible in principle to scientific knowing or understanding" [(28), p. 4].

Now, on the one hand, there seems to be a growing appeal to the epistemic authority of experts (in line with the reasons presented above); on the other hand, however, in the public process scientific naturalism often ends up clashing with religious and various other moral and cultural values. In fact, the phenomena that are still to be explained in a scientific, shared and non-controversial way include central aspects of the human world, which are defined by their inherently normative and axiological nature. So, normativity potentially stands as one of the main obstacles to scientific naturalism and its claims of naturalization, as many of our decisions are based on criteria other than purely scientific ones, while being neither irrational nor unreasonable. Normativity constrains our thinking and our actions, in the sense that it presupposes that there are things we should think or do as well as assessments we should give (even if, often, we think or do something else). This fact has great importance for politics, where it takes the form of regulatory decisions made according to majority-based procedures.

In other words, science isn't in the business of answering moral questions: rather, its findings can be used to inform answers to moral questions (Lavazza and Farina, under review). But since moral questions are irreducibly normative, and since science (according to naturalists) is irreducibly non-normative, there is no chance that science can discover all truths (provided there are any normative truths). In this sense the choices suggested or directly made by experts should be mostly neutral. And if they are not, they should be justified not only by the epistemic authority of their holders but also by acceptable public reasons expressed in the political process. Ideally, in the public arena different comprehensive visions are compared and everyone can understand and accept the proposed arguments without one's (epistemic) authority being an element of relevance in the discussion. The latter, however, must remain within the

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[11] https://www.thehastingscenter.org/coronavirus-and-the-crisis-of-trust/ (accessed April 2020).

[12] Cf. https://www.vox.com/2020/2/10/21124881/coronavirus-outbreak-china-li-wenliang-world-health-organization (accessed April 2020).

[13] This was also thanks to the interventions of the World Health Organization, of internationally renowned universities and of websites such as Johns Hopkins, Centers for Disease Control and Prevention.

canons of procedural rationality – something that is not always easy to define but which we can all intuitively understand (29, 30).

However, in some cases experts' assessments are not neutral in the sense explained above. Two examples that occurred during the Covid-19 pandemic in Britain and in the United States may be used as good illustrations of this point.

The British Case of Herd Immunity

At the beginning of the COVID-19 pandemic, Prime Minister Boris Johnson was very skeptical about the possibility of an epidemic taking place on a large scale in Britain. For this reason, Johnson opposed the implementation of draconian measures of prevention, such as the suspension of activities already implemented or the banning of large meetings or international travels, both for economic reasons and for idealistic reasons, mostly political considerations (involving -for instance- respect for citizens' rights). However, some experts also supported Johnson's position with scientific motivations, including the Chief Scientific Adviser to the Government, Patrick John Thompson Vallance, and the UK government's chief medical adviser, Chris Whitty[14]. Whitty and Vallance initially endorsed the government's prudent strategy to fight coronavirus, based on the Contain-Delay-Mitigate-Research (31): as a result, those who had symptoms were not tested, contrary to WHO's suggestion, and the government enforced at a societal level neither quarantine nor isolation. Vallance explained that Britain needed to acquire "herd immunity;" that is, at least 60% of Britons needed to contract Covid-19 in order to develop effective antibodies and no longer transmit the disease since SARS-CoV-2 occurs seasonally.

This health strategy is based on the utilization of an established scientific fact, "herd immunity," which is achieved when a certain proportion of the population develops antibodies to a certain infectious disease, either in order to stop the infection or keep it below a minimum threshold (32). Usually, herd immunity is achieved with the spread of a specific vaccine, as happened for example in the case of measles (33)[15]. Unlike the restrictive measures adopted in other European countries, the experts advising Johnson's government argued that such a strategy ought to be implemented to protect the elderly and the more fragile in the long term. This health policy, however, was immediately criticized by part of the scientific community and by the public as well. For some, Vallance's theory represented a huge risk that could have caused the deaths of hundreds of thousands of British people[16]. There are 67 million Britons, so 60% means about 40 million. With a lethality rate of 1% (this is a very conservative estimate), the approach suggested by Johnson could have easily resulted in about 400,000 deaths. And the British health care system could have been put under extreme pressure, with a very high number of patients admitted to intensive care for acute respiratory problems.

A working paper by the Imperial College Covid-19 Response Team (34) published on March 16, 2020, predicted Covid-19 deaths in the U.K. based on a range of policies and a range of reproduction numbers. In their worst-case scenario, which assumed a reproduction number of 2.6 and the (unlikely) absence of any control measures or spontaneous changes in individual behavior, researchers estimated 550,000 deaths. The day after the release of the report the government changed its strategy by announcing more drastic measures to prevent the contagion from spreading: school closures throughout the country and the restriction of many other activities up to the general lockdown, with the justification that scientific data had changed.

Richard Horton, the editor-in-chief of the medical journal The Lancet, commented that the attitude of the government and its medical and scientific advisors was incomprehensible (31), as was the decision to change strategy only after the Imperial college paper was released. In his view, the scientific data were the same since January and nothing had changed: in his opinion, what had happened in China and what was happening in Italy was clear enough. A journalistic inquiry conducted by the Reuters found that "the scientific committees that advised Johnson didn't study, until mid-March, the option of the kind of stringent lockdown adopted early on in China […][17]. Britons, many of them assumed, simply wouldn't accept such restrictions." According to the investigation, "as they watched China impose its lockdown, the British scientists assumed that such drastic actions would never be acceptable in a democracy like the UK. Among those modeling the outbreak, such stringent countermeasures were not, at first, examined[18]." In the light of this reconstruction, the Imperial College's report did not contain figures other than those which should have been already assessed and understood by government's experts but simply made them public without political mediation[19].

At the time of writing, facts are too recent to have sufficient sources and evidence to reconstruct the causes of the decisions by the British Government. Our discussion is only intended to highlight how the intervention of experts in health policymaking can have a huge impact that goes beyond the simple application of knowledge and expertise to the given situation in order to make predictions or suggest the best means of achieving certain ends. In the same paper mentioned above, Ferguson et al. (34) acknowledged that "the social and economic effects of the measures which are needed to achieve this policy goal [of suppressing the epidemic] will be profound." But researchers expressly did not "consider the ethical or economic implications" of choosing an aggressive "suppression" strategy rather than milder measures aimed at "mitigation."

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[14]Cf. https://www.theguardian.com/world/2020/mar/03/uk-government-coronavirus-plans-strip-fire-and-police-to-essentials-Covid-19. As of March 13, 2020, Great Britain was the only one among the main Western countries not to have closed schools and suspended sporting events, and it was also the only one not to have taken any measures involving restriction of travels, restriction of mass gatherings and domestic lockdown, https://twitter.com/lewis_goodall/status/1238242156365721609/photo/1. (accessed April 2020).

[15]https://www.bbc.com/news/uk-51865915 (accessed April 2020).

[16]CF https://www.bbc.com/news/uk-51857856 (accessed April 2020).

[17]https://www.theguardian.com/commentisfree/2020/mar/18/coronavirus-uk-expert-advice-wrong (accessed April 2020).

[18]https://it.reuters.com/article/healthcareSector/idUKL4N2BV3CA (accessed April 2020).

[19]https://www.reuters.com/article/us-health-coronavirus-britain-path-speci/special-report-johnson-listened-to-his-scientists-about-coronavirus-but-they-were-slow-to-sound-the-alarm-idUSKBN21P1VF (accessed April 2020).

As former Uk minister Rory Stewart rightly pointed out before the country took more restrictive measures: "Britain is trying to follow a theory of herd immunity. In other words, they believe it's impossible to get on top of this disease, and therefore you have to ultimately let it run through the population. That is a very, very big choice. It's not a scientific choice, it's fundamentally a political choice." Stewart added that he thought the government had made the wrong judgement by not being transparent and said that "when the public understands that implicit in this argument is that they would rather that people died earlier to prevent more people dying later, the public will be very troubled."

Our goal in this article is not to assess the scientific soundness of the herd immunity hypothesis. On the one hand, "there is very little evidence to support the hypothesis that herd immunity would work in this case – we are dealing with a very new virus and most evidence on herd immunity comes from the context of vaccination[20]. [And], even if there were a chance that herd immunity would work as a strategy, the timing of it would have to be perfect for it to work, which seems extremely unlikely given the lack of evidence" (35). On the other hand, it cannot yet be ruled out at the time of writing that the virus might have already infected a significant proportion of the British population, as claimed by a study conducted by a group of researchers led by Sunetra Gupta (36). According to preliminary data, <1 in a thousand of those infected with SARS-CoV-2 will develop symptoms requiring hospitalization. Most individuals develop very mild symptoms or no symptoms at all. Moreover, it is well-documented how difficult it is to make reliable and realistic predictions about the development of an epidemic due to an unknown pathogen and to implement the most effective containment strategies [see (37)].

What we want to emphasize here is that public health policies can have more or less solid scientific foundations but still have consequences that are not included within the scope of purely medical decisions. In other words, the epistemic authority of experts -in our view- is not enough to justify the implementation of a rather political decision, such as that of herd immunity when it includes all its societal consequences. In this sense, we agree with the arguments presented by Ienca and Shaw (35): "Aiming for herd immunity involves a conscious policy decision to let perhaps half a million people die – mainly people over age 70 who are much more likely to require intensive care beds and to die of the virus (the same group discriminated against in Italian guidelines on rationing intensive care provision). [And] if this were a clustered clinical trial, no ethics committee on the planet would approve a design with such weak evidence and such high risks."

But the key point is that these decisions must have a justification that is not only epistemic, based on the knowledge that is methodologically (scientific naturalism) and empirically (observation and experiments) grounded. If the aim is to combat an epidemic with a strategy that voluntarily exposes a large number of people to contagion, then this health policy incorporates values [such as those of a utilitarian approach

(38) that privileges the maximization of the overall good, even at the price of the suffering of some] that simply cannot be presumed to be imposed on a modern pluralist society. In these cases, just like political parties, religious groups or opinion movements, experts must be able to articulate their proposals in terms of reasons that are accessible to all, so that every citizen has the opportunity to evaluate and adhere to them or to reject them in the usual deliberative process carried out in the public arena in accord to the shared procedural political values (29).

For example, the well-being of the majority cannot be preferred over the absolute value of every human life, based on the extrinsic authority of the person proposing one position or another. In this sense, experts with epistemic authority are not *per-se* more entitled than others to defend a certain value or a moral principle, contrary to what happens when a technical solution has to be chosen.

This means that not even approaches opposed to the British one, such as the extremely restrictive health policy adopted by countries like Italy, China, or Kazakhstan, are in principle immune from the abovesaid considerations. Excessive caution in countering a potential threat can, in fact, exploit the epistemic authority of experts to introduce measures that violate civil liberties and rights or severely restrict the ability to exercise private business. Also, in this case, the justification for similar measures should not only be the purely technical type typically provided by medical experts. In fact, such decisions can be countered by changing empirical data, and therefore value considerations must also be taken into account and framed in the political landscape according to the canons of public reason.

The US Case of the Exclusion of Disabled People From Care

When the Covid-19 crisis in Italy worsened (beginning of March 2020), the Italian Society of Anesthesia, Analgesia, Resuscitation and Intensive Care (SIAARTI) predicted an increase in cases of acute respiratory insufficiency (requiring hospitalization in the Intensive Care Unit) of such magnitude as to cause a strong imbalance between the population's clinical needs and the effective availability of intensive resources. Faced with this scenario, it was believed that it might be necessary to adopt "criteria for access to intensive care," "not only in strictly clinical appropriateness and proportionality of care but also in distributive justice and appropriate allocation of limited healthcare resources[21]."

In a scenario akin to "disaster medicine," for which there are many concrete indications for doctors and nurses involved in difficult choices, SIAARTI proposed some "clinical ethics recommendations for the allocation of intensive care treatments, in exceptional, resource-limited circumstances." These included "an extension of the principle of proportionality of care, allocation in a context of a serious shortage of healthcare resources," and the "aim at guaranteeing intensive treatments to

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[20]https://fortune.com/2020/03/14/coronavirus-uk-cases-herd-immunity-Covid-19/ (accessed April 2020).

[21]http://www.siaarti.it/SiteAssets/News/COVID19%20-%20documenti%20SIAARTI/SIAARTI%20-%20Covid-19%20-%20Clinical%20Ethics%20Reccomendations.pdf (accessed April 2020).

patients with greater chances of therapeutic success." Therefore, it was a matter of favoring the "greatest life expectancy." The need for intensive care must be integrated with other elements of "clinical suitability," thus including the type and severity of the disease, the presence of comorbidities, the impairment of other organs and systems, and their reversibility. This means not necessarily having to follow a criterion for access to intensive care like "first come, first served." It is implicit – underlines the document – that the application of rationing criteria is justifiable only after all the actors involved have made all possible efforts to increase the availability of resources and after every possibility of transferring patients to centers with greater availability of resources has been evaluated[22].

This type of guidelines, where choices are left to experts in the field, may generate an understandable debate, but they fall within the competence of medical managers and do not give rise to specific disagreements because, in the face of the objective temporary impossibility of treating all patients in the best possible way, certain criteria simply must be followed. And the criteria proposed by SIAATRI, like similar criteria proposed in other countries, are recognized as reasonable and supported by the specialist knowledge of experts, who are the most qualified to make these choices, although there is always room for dissent and difference of opinion.

A different case is what happened in some US states, where some criteria have been either reconsidered or set from scratch in the face of the Covid-19 emergency. For example, at the end of March 2020, people with spinal muscular atrophy were excluded from intensive care in Tennessee. In Minnesota, cirrhosis of the liver, lung disease and heart failure were considered as diseases that had priority over Covid-19. In Michigan, precedence was given to workers employed in essential services. And in Washington State, New York State, Alabama, Tennessee, Utah, Minnesota, Colorado, and Oregon, doctors were required to assess the general physical and intellectual ability of patients with Covid-19 before intervening with resuscitation procedures.

Different approaches emerged in the strategies prepared or revised by local experts, with a common trend. Of the 36 or so states that made their criteria known, a dozen also listed considerations with respect to the intellectual capacity of patients, and others indicated precise conditions that could lead to a lesser recognition of disabled people's rights to care as opposed to other patients[23]. In the Alabama guidelines, for instance, it is claimed that "persons with severe intellectual disability, advanced dementia or severe traumatic brain injury may be poor candidates for ventilator support;" and that "persons with severe or profound intellectual disability, moderate to severe dementia, or catastrophic neurological complications such as persistent vegetative state are unlikely candidates for ventilator support[24]."

These rules and the reference to "cognitive abilities" in the guidelines of Washington state or to "severe neurological

disorders" in those of Maryland and Pennsylvania have aroused the protests of the associations for the defense of disabled people. Disability Rights Washington, Self-Advocates in Leadership and The Arc of the United States have sued the State of Washington to prevent the enactment of the criteria for access to life-saving care for Covid-19[25]. And other organizations have appealed to the federal government to impose on local authorities and hospitals the principle that disabled people are entitled to the same treatment as all other Covid-19 patients[25].

Disabled people's associations have addressed the leaders of the Senate, and some MPs have written to the Department of Health and Justice inviting them to provide clear guidance to protect people with disabilities[26]. In the US, in fact, civil rights laws prohibit discrimination on the basis of race, color, national origin, disability, age, and sex. Subsequently, Alabama had to revoke its plan to deny ventilators to patients with cognitive disabilities in the event of a shortage of them[27]. In fact, the HHS Office for Civil Rights has determined that the plan violated federal civil rights laws.

The guidelines of individual states may reflect the positions of health experts alone or also the political orientations of legislators[28]. However, the examples given so far point to situations where proposals or decisions made by experts – based on their technical expertise and presumably in good faith, i.e., without explicit cultural, ideological, political or religious views or biases being at play – cannot be justified simply by their epistemic authority (i.e., based on the fact that experts know more than laypeople, are more effective in a particular circumstance and ground their views on scientific naturalism, which is the most reliable epistemic theory). The possible use of the disability criterion to put people with disabilities at the bottom of the list of those who can access intensive care, as shown by the reactions provoked in the United States, must be publicly justified with reference to reasons that can convince the bearers of general values and interests within society.

It is certainly necessary to decide who should be assigned a ventilator in the ICU when there are more patients than devices available. And it does not seem sensible to choose by fate or according to the extemporary judgment of the clinicians. Now, reasonable general criteria such as those exposed in the document of the Italian Society of Resuscitators can be shared and accepted on the basis of the epistemic authority of the experts. Criteria that are more controversial or that may conflict with widespread beliefs and rules (e.g., equal rights and opportunities for people with disabilities) ought instead to be proposed and argued for on the basis

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[22]Ibidem.

[23]https://www.nytimes.com/2020/03/31/us/coronavirus-covid-triage-rationing-ventilators.html (accessed April 2020).

[24]https://int.nyt.com/data/documenthelper/6846-alabama-triage-guidelines/02cb4c58460e57ea9f05/optimized/full.pdf#page=1 (accessed April 2020).

[25]https://dredf.org/the-illegality-of-medical-rationing-on-the-basis-of-disability/ (accessed April 2020).

[26]https://www.propublica.org/article/people-with-intellectual-disabilities-may-be-denied-lifesaving-care-under-these-plans-as-coronavirus-spreads (accessed April 2020).

[27]https://www.aapd.com/wp-content/uploads/2020/03/Covid-19-Response-Package.pdf (accessed April 2020); https://www.disabilityscoop.com/2020/03/30/trump-administration-says-disability-no-reason-to-deny-Covid-19-care/28065/ (accessed April 2020).

[28]https://gizmodo.com/alabama-disavows-plan-to-deny-ventilators-to-Covid-19-p-1842770059 (accessed April 2020).

of reasons that do not only refer to established biomedical knowledge but also meet the requirements of procedural political discussions bound to assumptions that all citizens might reasonably share.

Having discussed these two case studies, we are now able to draw an intermediate conclusion. It appears that the role of experts is crucial in fighting an unknown pandemic as political choices can be extremely slow and ineffective. Scientists' suggestions may be unpopular and go against shared beliefs and contingent interests but are in most cases based on specific expertise that other citizens do not have. Involving experts, even preventively, can be the best strategy for legislators and decision-makers who want to defend their society from the threat of an unknown virus. In this sense, cultural and social trends aimed at devaluing the authority and role of experts in society must be countered. However, it is advisable that experts' recommendations are always discussed through the prism of public reason. We analyse this point at length in the next section of this paper.

DISCUSSION: WHAT WE CAN LEARN FROM THE RESPONSES TO THE PANDEMIC

As we have seen above, the action of experts and scientists is not always as technical and neutral as it is supposed to be (39, 40). Experts' recommendations have sometimes strong axiological implications, involving very different treatment decisions and different sets of cultural, moral, or religious values. In such cases, experts should justify their recommendations (which effectively become obligations) by the canons of public reason within the political process. In fact, when values come into play it is no longer just a matter of finding the "best technical solution," but also of making discretionary choices that affect citizens and that cannot be imposed solely on the basis of epistemic authority.

An example of technical recommendations that end up having a major effect on the balance of principles and rights within a liberal democracy is the tracking of people infected by Covid-19 and of those who have come in contact with them. Indeed, an effective measure to curb the epidemic seems to be to follow (and reconstruct) the real-time movements of all those who are positive and those who have been in contact with them. It is thus possible to quickly circumscribe an outbreak and prevent it from spreading because even coronavirus-negative people would know immediately which people and areas to avoid. This makes it possible both to intervene clinically in a targeted and more effective way and to act in an epidemiologically efficient way, avoiding the damaging effects of lockdown on citizens and economic activities[29].

This method, thanks to today's technological knowledge, infrastructure and dissemination of individual devices, seems quite simple to implement and indeed it is being implemented

(in countries like South Korea, for instance). It is enough to activate the GPS of each smartphone and thanks to a specific app, with the help of telephone operators, follow all the movements of the subjects "of interest" – for example, as mentioned, the person who tested positive and all those who are close to them, in order to isolate, as far as possible, the vectors of contagion[30]. Alerts to all those who are in the outer circle around the area subject to preventive "closure" make it -in principle- possible to stop the chain of virus transmission. Tests are not only carried out on symptomatic patients but also on a sample basis according to a specially designed statistical programme.

Now, let's suppose that this system is scientifically grounded and proves to be truly better than lockdown in terms of costs and benefits because it reduces overcrowding in intensive care units and is less expensive in terms of effects on the GDP. It could also be more advantageous in terms of individual rights, given that general confinement in one's own home drastically restricts the fundamental rights of movement and assembly (like a prison sentence, in many respects). However, on the one hand, digital tracking "only" nullifies the right to privacy (provided that the system is mandatory, but optional compliance also poses problems of social pressure and possible discrimination against dissidents). On the other hand, though, the risk of using the monitoring strategy is that something that is acceptable in principle may then become an unacceptable constant danger for all citizens.

In fact, when the lockdown ends, everyone can go back to their own activities and the negative effects of various kinds can be dissipated within a relatively short period of time. Once the tracking system is implemented, however, not only is the data acquired during the epidemic stored forever, but the entire tracking system becomes available for new uses. Also, it should be noted that the psychological or moral resistance to the implementation of full-scale tracking that the majority of people may have before the implementation of such measure during the pandemic may well be weakened after its actual implementation when the pandemic it's over (this is because people get used to it and may slowly forget about it). This opens to the possibility of a large swathe of people being tracked and almost automatically accepting more restrictions on their rights, which is quite problematic. So, the vulnus inflicted on the right to privacy can subsequently be transformed into a powerful mean to control citizens and to give authorities immense, unchecked, and unbalanced power.

In this sense, following Ienca and Vayena (41), we suggest that experts should propose recommendations that are: "(i) proportional to the seriousness of the public-health threat, (ii) limited to what is necessary to achieve a specific public-health objective, and (iii) scientifically justified." In the case of personal tracking in order to reduce SARS-CoV-2 infections, an efficient technical solution may imply, as an unintended but foreseeable effect, a temporary or even prolonged shift

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[29]https://www.theverge.com/2020/4/10/21216484/google-apple-coronavirus-contract-tracing-bluetooth-location-tracking-data-app (accessed April 2020).

[30]https://techcrunch.com/2020/04/10/apple-and-google-are-launching-a-joint-covid-19-tracing-tool/ (accessed April 2020).

in the political balance. This type of expert recommendation, while technically flawless, is not neutral for individuals and for society and should, therefore, be proposed and evaluated according to procedures that do not merely establish the epistemic authority of the advocates and the recommendation's adherence to scientific criteria. The values at stake are different and conflicting – the right to health, the right to privacy, political freedom – and the prevalence of one or the other should be entrusted to an assessment typical of decisions made in the political process with the participation of all citizens, usually in the forms of representative democracy. And just as we should never give up the contribution of experts, so the state of emergency and the limited time available to make an effective decision should never prevent such an assessment when axiological aspects that go beyond epistemic authority are at stake.

CONCLUSION

In the 2020 Covid-19 pandemic, medical experts (virologists, epidemiologists, public health scholars and statisticians alike) have become instrumental in suggesting policies to counteract the spread of coronavirus. Given the dangerousness and the extent of the contagion, almost no one has questioned the suggestions that these experts have advised policymakers to implement. Quite often the latter explicitly sought experts' advice and justified unpopular measures (e.g., restricting people's freedom of movement) by referring to the epistemic authority attributed to experts.

In this paper, we analyzed the basis of this epistemic authority and the reasons why in this case it has not been challenged, contrary to the widespread tendency to devalue expertise that has been observed in recent years. In addition, in relation to the fact that experts' recommendations are generally technical and supposedly neutral, we noted that in the COVID-19 crisis different experts have suggested different public health policies. We considered the British case of herd immunity and the US case of the exclusion of disabled people from medical care. In those cases, decisions had strong axiological implications, deeply affecting people in very sensitive domains.

Based on our theoretical and empirical analysis, we argued that experts should justify their recommendations - which

effectively become obligations-by the canons of public reason within the political process because when values are involved it is no longer just a matter of finding the "best technical solution," but also of making discretionary choices that affect citizens and that cannot be imposed solely on the basis of epistemic authority. Epistemic authority may justify recommendations in strictly technical matters, but some decisions which are not only technical but also normative must have a shared political, cultural, and perhaps even ethical justification. We scrutinized the political and moral aspects involved the political process, in which every citizen exercising their reasonableness within the framework of liberal procedures has the right to speak and to assert their reasons. The public reason consists of the forms of evidence and argument used in making decisions accountable to citizens by the state and to fellow citizens by other citizens. This implies the construction of "civic epistemologies" with which to evaluate procedures and decisions concerning new aspects of the application of scientific knowledge to people' lives (42).

We thus agree with Kearnes et al. (43) when they say that expert judgements don't exist in a vacuum. They arise from specific social and political contexts. To understand them, we, therefore, need to acknowledge the tacit assumptions embedded within expert knowledge claims, especially assumptions concerning how publics respond to expert advice.

In this vein, the lesson we can learn from the Covid-19 pandemic is two fold. The first idea is that the epistemic authority of experts in biomedical disciplines is fundamental and should be given priority by political authorities[31]. The second idea is that not all expert recommendations need to be automatically implemented, as some recommendations include axiological and regulatory elements that should be justified in the political process, not only epistemically but also normatively. In those cases, the decision-making process should, therefore, be civil, participatory in character, and perhaps even political, without giving up the criteria of competence and rationality.

AUTHOR CONTRIBUTIONS

All authors contributed equally to the writing of this manuscript.

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[31] https://theconversation.com/we-should-listen-to-coronavirus-experts-but-local-wisdom-counts-too-134034 (accessed April 2020).

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How the Media Places Responsibility for the COVID-19 Pandemic—An Australian Media Analysis

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Global pandemics are likely to increase in frequency and severity, and media communication of key messages represents an important mediator of the behavior of individuals in response to public health countermeasures. Where the media places responsibility during a pandemic is therefore important to study as blame is commonly used as a tool to influence public behavior but can also lead to the subjective persecution of groups. The aim of this paper is to investigate where the media places responsibility for COVID-19 in Australia. Specifically, we identify the key themes and frames that are present and observe how they changed over the course of the COVID-19 pandemic in relation to government actions and progression of the pandemic. Understanding media representations of the COVID-19 pandemic will provide insights into ways in which responsibility is framed in relation to health action. Newspaper articles from the Australian and the Sydney Morning Herald were sampled between January 20 and March 31 2020 on every second Monday. Factiva was used to identify and download newspaper articles using the following search criteria: "COVID-19" OR coronavirus OR "Wuhan virus" OR "corona virus" OR "Hebei virus" OR "wet market" OR (Wuhan AND virus) OR (market AND Wuhan and virus) or (China AND Virus) or (Novel AND Virus). Articles were imported into Nvivo and thematic and framing analyses were used. The results show that framing of the pandemic was largely based on societal issues with the theme of economic disruption prevalent throughout the study time period. Moral evaluations of the pandemic were infrequent initially but increased co-incident with the first signs of "flattening of the curve." Explicit examples of blame were very rare but were commonly implied based on the causal origin of the virus. The Australian printed media were slow to report on the COVID-19 pandemic, in addition they were reluctant to apportion blame until the end of the study period, after confirmed case rates had begun to slow. This is interpreted as being due to an evaluation of the pandemic risks as low by the media and therefore the tools of othering and blame were not used until after the study period when the actual risks had begun to abate, more consistent with an inquiry than a mediating mechanism.

Keywords: media analysis, responsibility, COVID-19, framing analysis, thematic analysis, blame

INTRODUCTION

With global confirmed cases approaching 13.1 million and confirmed deaths approaching 574,000 (at July 2020) (1) the COVID-19 (SARS-CoV-2) pandemic of 2019–2020 represents the largest public health emergency since the Spanish flu of 1918 (2).

In Australia, newspaper and television information campaigns have been announced by the Prime Minister as a source of information for the public during the evolving COVID-19 pandemic (3). Through these various forms of media, the public health and economic response to the pandemic in Australia has been swift and advised by public health officials and epidemiologists (3). This was demonstrated by the activation of a COVID-19 emergency response plan by the federal government on 27 February 2020 (4) a pandemic preparedness response plan released in advance of the World Health Organization (WHO), which announced a COVID-19 public health emergency on 30 January 2020 (5) with an escalation to "pandemic" characterization on 11 March 2020 (6). To date, extensive public health guidelines, mandated by the Australian federal government, have been announced to limit person-to-person transmission within the public. Guidelines have been based on numerical modeling and the pathogenesis of the disease. Modeling has demonstrated that without 80–90% compliance by the public the pandemic could not have been controlled and that the early intervention by the federal government has meant that, to date, Australia has largely avoided the high mortality rates associated with the exponential rise of cases of COVID-19 relative to many other first-world nations such as the US, UK, and Italy (7, 8).

Reviews into biosafety suggest that epidemics not-unlike COVID-19 are likely to increase in frequency and become more harmful due to globalization and an increase in human-animal contact (9). Therefore, the media's timing and reporting of accurate statistics and advice represents an important topic for discussion with respect to public health emergencies. Previous work discussing mistrust of the media to provide accurate information to the public has shown the material effect of poor perception of the media and therefore poor public response to crises (10, 11).

Previous epidemics, such as Avian Flu and other threats of pandemic influenza, have led researchers to explore the media-driven messages portrayed to the public through newspapers

(12–16). These examples serve to highlight the importance of media messaging, as the implications for non-compliance can have dire effects on public health. The ability to deduce personal risk and therefore compliance with government mandated guidelines is associated with trust of the media. Therefore, how the media portray health crises is an important influence not only on public behavior (17) but also on the long-term repercussions for health (18).

The framing of responsibility during health crises is known as a sense-making and coping mechanism for individuals, but which can also lead to stigmatization of an affected group (19). Therefore, the role of the media and how they frame responsibility (e.g., on individuals and/or institutions for their various roles and responsibilities) for a health crisis represents an important component of messaging to the public. By placing responsibility for a health crisis, such as a pandemic, the media are also able to mediate public behavior to panic by inducing a sense of otherness which has the effect of allaying fears by framing them as distant (20).

This study evaluates how two high readership and broad demographic newspaper media outlets frame responsibility for COVID-19. The study applied a qualitative approach to both framing and thematic analysis to the initial 11 weeks following the first publications of the COVID-19 pandemic by the two newspapers, the Australian and the Sydney Morning Herald. This study contributes to the limited literature on how the media have responded to the COVID-19 pandemic and was completed in response to calls for how the media portrays COVID-19 (18).

METHODS

Scoping the Dataset

Newspapers selected for the media analysis were limited to Australian print media that were accessible through the electronic database Factiva. When planning the study, multiple newspapers were considered for inclusion in the media analysis (Search 1—**Table 1**). However, given the exceptionally high article numbers ($n = 8,536$) related to the search terms used to scope the dataset (**Table 2**), two newspapers were ultimately chosen to limit the sample size, The Australian (AUS) and the Sydney Morning Herald (SMH) (Search 2—**Table 1**). The rationale for selection of these two newspapers were that they offer high readership ADDIN EN.CITE (21, 22), have traditionally diverse political orientations (23, 24)

TABLE 1 | Search method summary.

	Newspapers	Time period	Article number
Search 1	The Australian, The Advertiser, Sydney Morning Herald, The Age, Australian Financial Review	1 October 2019 to 31 March 2020 (past 6 months)	$n = 8,536$ articles total
Search 2	The Australian, Sydney Morning Herald	1 October 2019 to 31 March 2020 (past 6 months)	$n = 3,878$ articles total
Search 3	The Australian, Sydney Morning Herald	20 January to 31 March 2020	$n = 3,868$ articles total
Final Dataset	The Australian, Sydney Morning Herald	20 January 2020 to 31 March 2020 Every second Monday starting 20 January 2020 ending 30 March (6 days over 11 weeks)	$n = 313$ articles total ($n = 171$ The Australian; $n = 142$ Sydney Morning Herald)

and diverse readership demographics (25). Articles in both newspapers were limited to those that were printed, with the following excluded: online publications, blogs and audio and visual media. Printed newspapers are associated with higher credibility than their online counterparts (26, 27). Given the importance of credibility in the media related to past pandemics (10), we selected print media as the preferred media medium (10, 28, 29).

Search Terms

The search terms used for the study aimed to capture all articles available within the respective newspapers as related to the emerging COVID-19 pandemic and time period thereafter. Search terms were selected based on the changing nomenclature of the SARS-CoV-2 virus and its assumed epidemiological provenance (**Table 2**).

TABLE 2 | Search terms used to acquire article database.

Search terms	"COVID-19" OR coronavirus OR "Wuhan virus" OR "corona virus" OR "Hebei Virus" OR "wet market" OR (Wuhan AND virus) OR (market AND Wuhan AND virus) or (China AND virus) or (novel AND virus)
Search region	Limited to "Australia"

Time Period

The selection of a time period for this study was based on the emergence of COVID-19 around late-November 2019 ADDIN EN.CITE (30, 31), until 31 March 2020 (date of commencement of this study) (see **Figure 1**). To manage the large number of articles while retaining an accurate representation of the publications, articles published fortnightly on a Monday were selected for inclusion. Mondays were selected as they generally represented the start dates of many government reforms. Additionally, Mondays typically (but not always) followed the major announcements by the Australian federal and state governments related to COVID-19 status updates and associated guidelines. This selection was informed by the view that coverage of public health emergencies is highly event based with publication frequency reflecting case numbers and government action (32). The rationale for the fortnightly selection component was based on reducing the number of articles for analysis from $n = 670$ every Monday to $n = 313$ every second Monday given timing constraints.

The included articles were copied from Factiva to Microsoft Word, split into individual articles, arranged by date and appropriately named according to their Newspaper and order of publication (e.g., AUS001, AUS002) before uploading to Nvivo 12 (QSR International, Doncaster) for analysis. Articles were excluded if their content only made passing or no reference to COVID-19.

FIGURE 1 | Publication and COVID-19 frequency per day for the study time period.
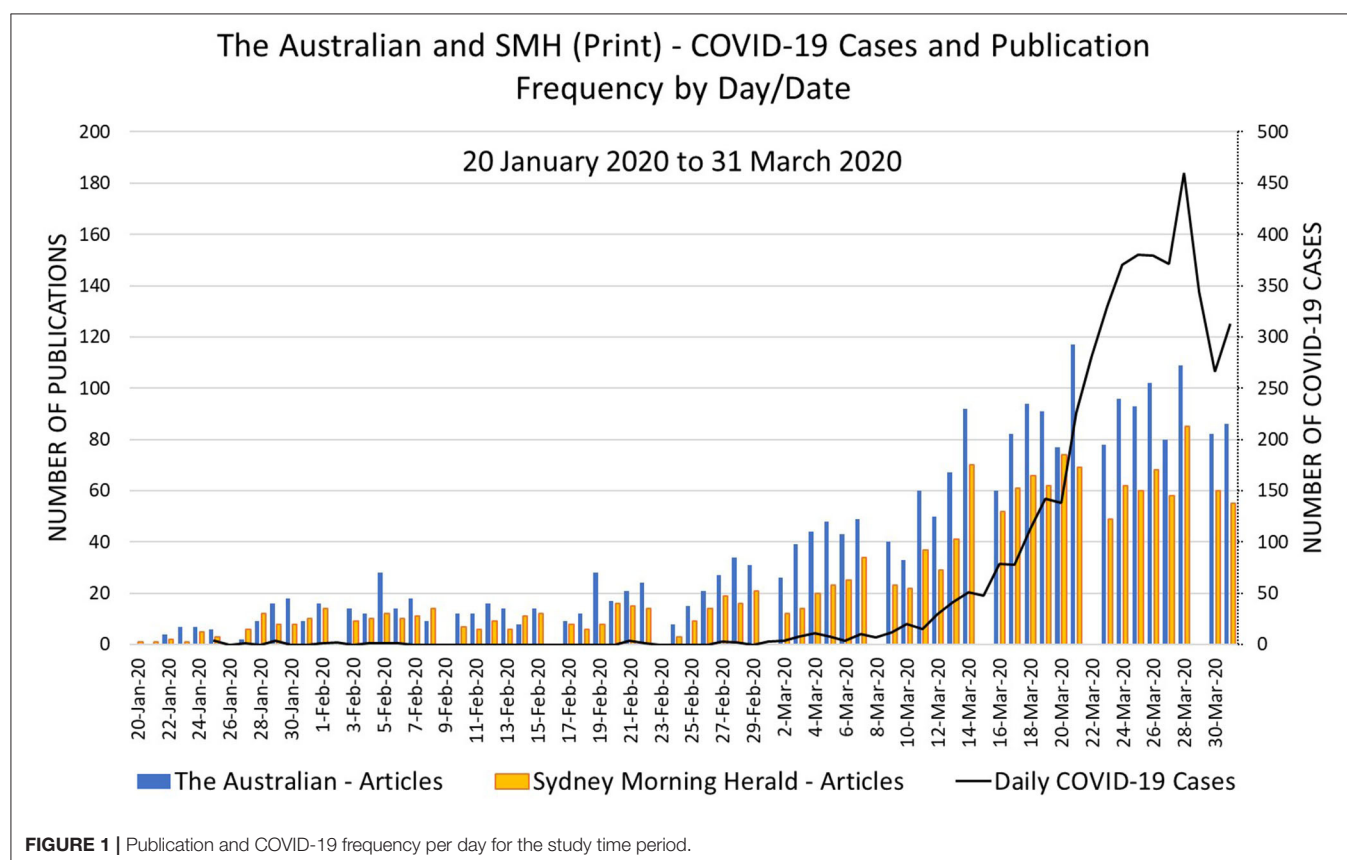
Analysis

To explore how the media place responsibility for COVID-19 we took an inductive thematic and framing analysis approach to media analysis as previously used by Foley et al. (33) This consisted of the hand-coding of separate thematic and framing analysis. Hand-coding as opposed to computer aided searches for characteristic search terms was selected as it allows for the comprehension of the sample articles beyond literal definitions (34).

Thematic analysis is a commonly used qualitative data analysis technique that seeks to identify common themes, ideas, and patterns within a given dataset (35). The technique was selected as it offers flexibility in application to an inductive approach to data analysis and its previous use in media analyses (34, 36, 37). Qualitative framing analysis is also commonly used in media analysis given its usefulness as a heuristic tool (33, 38). To complete the thematic analysis, author TT began thematic analysis of the articles chronologically starting with articles from the SMH followed by The Australian. Initially a selection of articles was read and major themes were noted to familiarize the author with the content. Axial and selective hand coding of the data followed in the NVivo software package to develop initial coding structures which were reviewed by Authors AW, ET, EM, and PW. This early stage coding later developed into more complex aggregations of nodes that were defined by their similarity. For example, nodes associated with the economic impact of COVID-19 that were loosely distributed within the coding "tree" were grouped under more definitive categories including "Disruption/Economic/Financial market" or "Education." During thematic analysis, Author TT frequently presented and discussed observations, methods and updates of the analysis with Authors AW, ET, PW, and EM.

As outlined by Foley et al. (33, 39) we applied a framing analysis approach adapted from Entman (40), which was adapted by Matthes and Kohring (41). This framing analysis method defines the Social, Medical and Behavioral frames as each being made of four frame components Causal Attribution, Moral Evaluation, Problem Definition, and Treatment Recommendation. These frame components form logical divisions within each frame into which data can be appropriately coded or categorized (see **Tables 4–6**). As outlined by Foley et al., the framing analysis followed thematic analysis (39). However, unlike Foley et al., this was undertaken immediately after completion of every ten thematic analyses. The decision to change the methodology was driven by timing constraints and differed from the Foley et al. method which called for framing analysis to only begin after the completion of all thematic analysis (39). Conducting the framing analysis in small batches allowed for knowledge retention of the themes and narrative which enabled faster decision making for the framing analysis. Consistent with the thematic analysis process, observations and discussions of the framing analysis were communicated to Authors AW, ET, EM, and PW.

A final review of the data by Author TT queried the themes and words frequency of individual nodes as coded. A word search within the articles of those common terms presented a list of paragraphs where those terms appeared uncoded during the first pass analysis. These terms were checked for relevance to the thematic and framing analysis and either added or passed over. This final check yielded few additions to the analysis, confirming that the majority of the codes had been captured already.

Following the completion of both thematic and framing analysis, the database of results was reviewed by authors ET and AW for completeness and decision rationale. No significant changes to the analysis were made following the review.

RESULTS

A total of 313 articles were identified, 310 included, and three excluded. Articles were excluded if their content only made passing or no reference to COVID-19.

Following significant coding, both thematically and through framing analysis, it became apparent that substantial overlap of the themes and the framing existed. This was made evident on the completion of the coding of the SMH articles in their entirety and the aggregation of the thematic codes. For example, the hand-coded themes of "disruption" and their sub-categories of "financial markets, sport, schools etc." were largely a reflection of the "societal" frame and "problem definition" frame component. Similarly, thematic coding of "opinions" and subcategories of "positive/negative" and child categories of "government, process, community" etc. were almost direct reflections of the "societal" frame and "moral evaluation" frame components. In large, the thematic coding represented an albeit more granular representation of the framing analysis. For this reason, the results are presented as the thematic analysis results as represented within the frames.

Quotes are referenced with their Newspaper ID and their frame and frame component categorization as per coding completed in Nvivo. For example: (SMH025)—Societal—Problem definition: "Example quotation" (Reference) would mean paper 025 from the SMH, in the societal frame and problem definition frame component.

Results Summary

The societal frame was consistently the dominant frame throughout the analyzed time period. From the onset, reporting of COVID-19 was dominated by the disruption of business, education and sports as a result of its transmission and social distancing guidelines. These themes were presented in the problem definition frame component for the societal and medical frames predominantly. Over time, the frame components of treatment recommendations and moral evaluations became more prominent with moral evaluations only becoming particularly prevalent toward the final weeks co-incident with the first signs of "flattening the curve." The causal attribution of the framing analysis did not change substantially during the time period and was often simply noted as "due to the spread of coronavirus."

From this analysis, the factor which appeared to have the greatest impact on how the media framed the COVID-19 pandemic was time, therefore the findings are presented in three time periods as per **Table 3** (1–Beginning, 2—Middle and 3—End). Each time period is presented as a framing analysis rubric which notes the common themes present in each frame and frame component. The matrices/rubrics are shaded to indicate

the prevalence of themes within the frames, with darker shades indicating prominence. Following the methodology of Foley et al. decisions on the relative prevalence and therefore shade of the components were made by (39).

The Beginning (Weeks 1 and 3)

During the early stages of the pandemic, the main issues presented concerned the definition of the problem at-hand. The dominant themes focused on the imminent threat to the economy. At this stage the media was coming to terms with the epidemiological nature of COVID-19 as based on foreign data and what it might mean for the economy at large. The first reported case of COVID-19 in Australia was confirmed on 25 January 2020 and this stimulated a rise in reporting on the topic. **Table 4** shows the frames and frame components most prominent in the early stages of the COVID-19 pandemic.

The first attempts to curtail the effects of COVID-19 included international border control. The immediate effect from this public health directive was the reduction of tourist numbers and restricting international students from entering the country. The net effect of these restrictions was highlighted in the articles primarily as financial disruptions to both the tourism and education sectors. These were coded as per the framing categories

as falling within the "societal" frame and "problem definition" frame component. For example:

(AUS010)—Societal—Problem Definition: "Australian Tourism Industry Council executive director Simon Westaway said the sudden halt to Chinese visitors would have ramifications for much of the industry and steps would need to be taken to develop a recovery plan. "The Chinese market is a 1.5 million-visitor-a-year market for Australia, bigger than New Zealand, and it generates in excess of \$12 bn in annual tourism receipts," Mr. Westaway said." (42).

(AUS011)—Societal—Problem Definition: "China is a critical economic partner for us. They"re the greatest source of foreign students—over 200,000 into Australia—(and) 1.4 million tourists," Mr. Frydenberg said "Together, those two sectors provide about \$16 bn to the Australian economy. And they are the recipients of around 30 per cent of our trade (43)."

The medical frame appeared as secondary to the societal frame. Themes present in the Medical Frame commonly included both domestic and foreign case numbers and potential symptoms. At this stage, data on the virology and timing of the symptom expression were sparse and resulted in broad treatment advice.

Moral evaluations were primarily limited to the Societal Frame and followed generally positive feedback toward the Government's response and negative sentiment toward the disruptive nature of COVID-19 related guidelines. Positive feedback of the Government was highlighted in contrast to the recent bushfires, an Australian natural disaster, where the government's response was commonly derided by the media for its poor performance. For example:

(AUS003)—Societal—Moral Evaluation: "Morrison [Prime Minister of Australia] has more than made amends for his missteps [bushfire disaster] and his rapid response to the

TABLE 3 | Study time period divisions.

Group	Time period	Articles
1—Beginning	20/01/20 to 03/02/20 (Weeks 1 and 3)	24
2—Middle	17/02/20 to 02/03/20 (Weeks 5 and 7)	55
3—End	16/03/20 to 30/03/20 (Weeks 9 and 11)	234
Total		313

TABLE 4 | Week 1 and 3, framing of COVID-19 ($n = 24$).

	Causal attribution	Moral evaluation	Problem definition	Treatment recommendation
Medical	Virus outbreak		Increasing cases Pneumonia, new coronavirus Origin Wuhan, China Symptoms and timing of, unknown	Flatten the curve Slow the spread Healthcare workers at borders—screening Seek medical advice if unwell Face masks and health checks Report people who show symptoms
Behavioral		Hypocritical actions Confusion, lack of information at airports Disappointment and helplessness due to poor process	Individuals separated from family	Calm down
Societal	Spread of coronavirus Pandemic High density living	Financial Public health at the expense of business Positive Gov. fast acting Gov. improved vs. bushfires	Economic impacts border closures supply lines disrupted Global financial market Unknown timing of impacts	Cancel flights Screening Travel advice Downgrade economic forecasts Evacuations Gov. imposed quarantine Control spread of Coronavirus Businesses call for aid

Shading of cells represent relative frequency of themes (white = uncommon, light gray = few instances, dark gray = common, black = very frequent occurrence).

potential pandemic posed by the coronavirus cannot be faulted. Morrison is now battling multiple national crises. Drought, fire, and plague. While foremost issues of human need and the well-being of the nation, there is an obvious political effect. And ultimately an economic one. Morrison has yet to shows signs of panic (44)."

(SMH005)—Societal-Moral Evaluation: "Some were angry at the government's decision to send them [Australians stranded in Wuhan, China] to Christmas Island [refugee detention center], while others said they were not being given enough time to evacuate (45)."

Responsibility/blame for the COVID-19 was not made explicit by either of the two newspapers during this time period. The newspapers acknowledged that the virus originated within Wuhan, China with no allocation of blame on any one group or process. Praise for China's co-operative approach and efforts to mitigate blame were apparent in the SMH:

(SMH005)—Societal—Moral Evaluation: "The Department of Foreign Affairs [Australian government department] said a Qantas plane had left Sydney yesterday for Hong Kong on the first leg of an assisted departure operation for which Chinese co-operation remains essential. "We are grateful to the Chinese government for its co-operative approach to date in this matter," a DFAT spokesman said (45)."

(SMH008)—Societal—Moral Evaluation: "The Chinese government has expressed disappointment with travel bans to and from China instigated by various countries. They need to understand that this is not an attack on China or the Chinese people. It is only a sensible extension of what China is doing internally with their own travel restrictions (46)."

The Middle (Weeks 5 and 7)

During the "middle" time period, the number of newspaper articles related to COVID-19 dramatically increased coincident with the exponential trend of increasing COVID-19 cases. The escalation of the pandemic set the tone for the framing with the media reinforcing the domestic risk posed by the pandemic. **Table 5** displays the prominent frames and frame components during week 5 and 7. This time period represented the first COVID-19 related death in Australia and the first swath of public health strategies to prevent further COVID-19 transmission by the federal government. The measures included travel bans, 14 days self-isolation for travelers and the release of a national emergency response plan for COVID-19 (4). By this stage, the economic effects of the pandemic were apparent with turmoil in the domestic and global financial markets. The need to balance the public health response with the economy was also discussed during this period. For example:

(AUS034) Societal—Problem Definition: "A second risk for investors is that governments in the West choose to sacrifice economic growth to try to slow the spread of the virus, as China did….Widespread school and office closures and quarantining of cities may slow the outbreak a little, but would deepen the economic damage. Japan is already going this way (47)."

(SMH21) Societal—Problem Definition: "Economic growth in NSW could slump to the lowest rate since the recession of the

early 1990s as key industries in the state struggle with the effects of the coronavirus outbreak and summer bushfires (48)."

The positive and negative longer-term outlooks of the pandemic were also being discussed in relation to opportunistic investment and climate/environment. For example:

(SMH026) Societal—Problem Definition: "Australian iron ore producers are set to benefit in the fallout from coronavirus as China will ultimately seek to stimulate its economy by investing in infrastructure (49)."

(SMH030) Societal—Problem Definition: "This brings us back to climate. If our economy is severely disrupted, the government will argue we cannot afford any more risks to jobs. It may even argue our coal exports are crucial to getting the global economy going again (50)."

The medical frame remained a secondary frame. Here, problem definitions were associated with the increase in epidemiological data available and thus the confirmed cases, origin, transmission mechanisms and risk profiles of various demographics were being discussed. As per the "beginning" weeks the emphasis remained on the number of cases illustrating the rapidly changing situation in Australia. For example:

(AUS023) Medical—Problem Definition: "It is understood Australians will have to pass a coronavirus check before being taken off the ship and vulnerable elderly will be the first to be brought home. Of the 200 Australians aboard, 16 have tested positive to the virus. So far 355 people have tested positive, after 70 new cases were found on Saturday (51)."

(SMH020) Medical—Problem Definition: "Two people in close contact with a confirmed case of coronavirus could be the first person-to-person transmissions in Australia. A man in his 40 s was diagnosed with COVID-19 following recent travel from Iran, NSW Health advised yesterday. The man isolated himself as soon as he became ill (52)."

Treatment recommendations focused on public health initiatives as actioned by the federal government in tandem with state governments. Within the societal frame, this largely drew on travel bans, businesses acting toward their financial interests and occupational health and safety and calls for financial aid from all sectors of the community. For example:

(SMH023) Societal—Treatment Recommendation: "The Morrison government put a travel ban on people coming from Iran as of yesterday because of the country's high death rate from coronavirus (53)."

(AUS035) Societal—Treatment Recommendation: "In a move to protect cashflows, companies are expected to delay paying their bills as the Reserve Bank warns the coronavirus outbreak poses a material risk to the national economy, which has had a 28-years run without a recession. Already some of Australia's biggest companies, such as construction giant CIMIC, have been using supplier "payday lending"-like schemes to blow out payment times, adding further pressure to supplier cashflows (54)."

(SMH029) Societal—Treatment Recommendation: "To have an impact Dr. Oliver said federal government stimulus measures would need to be worth "at least" $10 billion, and probably around

TABLE 5 | Week 5 and 7, framing of COVID-19 (*n* = 55).

	Causal attribution	moral evaluation	Problem definition	Treatment recommendation
Medical	Cruise ship confines Droplets coughing/sneezing High infection rates (R0) Person to person/close contact	Authorities and researchers' mistrust of foreign countries epidemiological data Poor hygiene practices—surfaces	Increasing cases Comparisons to SARS/MERS/Colds/influenza Deaths Predictions of spread difficult Demographics—vulnerable groups Potential healthcare overcapacity Weather- winter No vaccine	Infection and recovery = resistance Seek medical advice flu-like symptoms Slow the spread Quarantine Preparations
Behavioral	Individuals unsanitary actions	Individuals putting the community at risk	Individuals not taking pandemic seriously	Self-prescribed self-isolation
Societal	Spread of coronavirus Pandemic Coronavirus outbreak/epidemic	Gov. making good decisions Markets acting indifferently to circumstance Panic selling on markets Opportunistic price gouging	Economic Impacts Border closures Supply lines disrupted Job losses Global financial market Unknown timing of impacts Education markets Tourism Recession Opportunity investment School closures Already weak economy Economic growth vs. public health Climate/environment positives Sports Canceled games TV commitments Post-Covid-19 disruption Become an established pathogen Humanitarian—asylum seekers, migration ceased	Cancel flights Screening Travel advice Downgrade economic forecasts Evacuations Gov. imposed quarantine Control spread of Coronavirus Businesses call for aid Government stimulus aid request Less reliance on China more self-reliant Improve consumer confidence Government financial packages Passenger screening Develop vaccine Invest in public health tools Travel advise to other countries Review strategy effectiveness Opportunistic investment

Shading of cells represent relative frequency of themes (white = uncommon, light gray = few instances, dark gray = common, black = very frequent occurrence).

$20 billion, with the latter figure equal to about 1% of national gross domestic product (55)."

Within a medical context, the discussion on treatment focused on evidence-based processing of patients and epidemiological flattening of the curve through public health measures including quarantine. Of particular note, the time period also included the first indirect mentions of "herd immunity" as a possible outcome of infection, and loosely implied this as a potential treatment. The time period also made mention of the potential for vaccine development, and the need for preparation of the healthcare system given its limited critical care capacity. For example:

(AUS028) Societal—Treatment Recommendation: "But given how new COVID-19 is, there is no comparable scheme or vaccine that will help people become more resistant to the virus, although evidence suggests people who have been infected will be more immune in the future. Mr. Senanyake [researcher] said research showed COVID-19 wasn't mutating much, and that might help people build a resistance to it. "We suspect that in the short term if you get infected with COVID-19, you will be immune," he said (56)."

(SMH012) Societal—Treatment Recommendation: "We must anticipate a spread of infections from now and must build

medical systems and so on to focus efforts to prevent people from becoming gravely ill or dying (57)."

Moral Evaluations increased in prominence during the "middle" period. As per the "beginning" period these remained predominantly within the Societal Frame with more positive feedback for the government's response and some conflicting sentiment on financial markets behaving irrationally or indifferently. This also marked the first mention of opportunistic price gouging by businesses as demand outstripped supply for certain items, although occurrences of this complaint were infrequent. For example:

(AUS029) Societal—Moral Evaluation: "The coronavirus is becoming a most challenging national and international pandemic. The Morrison government has not put a foot wrong. Health Minister Greg Hunt and Chief Medical Officer Brendan Murphy have been superb for keeping all Australians in the loop (58)."

(SMH011) Societal—Moral Evaluation: "Pharmacy Guild Victorian president Anthony Tassone referred the issue to the Australian Competition & Consumer Commission last week, accusing Livingstone Pty Ltd. of "being opportunistic in significantly increasing the prices of their goods during a public health scare to maximize profit and price-gouge customers (59)."

Explicit framing of blame/responsibility was muted for this time period as per the "beginning" period although may be considered implicit in references to the origin of the virus.

(SMH018) Societal—Treatment Recommendation: "CSL, one of the world's largest biotechnology companies, has joined the global effort to combat the virus, lending its technical expertise and Seqirus vaccine to bolster the University of Queensland's efforts to develop an inoculation for Coronavirus (COVID-19). Coincidentally, CSL's existing Chinese facility and its 600 staff are situated in the Hubei Province at the epicenter of the epidemic (60)."

The End (Weeks 9 and 11)

By the "end" of the study period, several significant government guidelines aiming to flatten the epidemiological curve and provide support to citizens and businesses were in effect. These included several financial packages related to Medicare (Australian global healthcare system), JobKeeper (a new Australian government financial package aimed at maintaining employment), and income support (in the form of one-off payments to qualifying citizens). In terms of public health guidelines, limits to non-essential gatherings and restrictions on travel and aged care facilities were in place. At this point, the behavior of individuals was highlighted in regard to panic buying as the reality of the pandemic began to dawn on the population. **Table 6** displays the frames and frame components most prevalent in the final weeks of the study. Framing of the COVID-19 pandemic remained firmly within the societal frame. The medical frame was secondary but of note was the rise of the Behavioral frame for the first time in the study period.

The Problem definition and treatment frame components for both the medical and the societal frames remained as the prominent components reinforcing the "the problem at hand". The problem largely concerned the same economic and disruptive issues as per previous periods for the societal frame.

(AUS100) Societal—Problem Definition: "Sports broadcasters and administrators are scrambling to check the fine print of sports rights contracts worth hundreds of millions of dollars amid the threat of top football codes and the Olympics being suspended or canceled (61)."
(SMH129) Societal—Problem Definition: "Smaller operators have received protections from insolvent trading due to the coronavirus economic slowdown, but experts warn thousands will be facing long payment terms and unpaid invoices with little option for recourse (62)."

Within the medical frame the problem definition concentrated on the potential over capacity of healthcare services as per foreign states highlighting the problem as it was yet to arrive. As per previous periods, the number of confirmed cases ranked high as an indicator of the problem signifying the rapid change of the situation.

(AUS046) Medical—Problem Definition: "At the start of last week, Australia had reported 63 cases of COVID-19, 10 of them involving passengers taken off the Diamond Princess cruise ship

in Japan. On Sunday, the total had climbed to 298, headed by NSW with 134 cases and Victoria with 57. NSW reported a spike of 22 new infections in a day, while Queensland had 26 additional cases over the weekend (63)."

Treatment recommendations for the frames were based on the immediate economic impacts for the societal frame, following the previous period's results on treatment. Although the economic disruption and call for aid dominated the discussion, as with the previous time periods, more reactive treatments to the immediate large-scale societal issues were being sought.

(AUS051) Societal—Treatment Recommendation: "Employers including [supermarket and hardware stores] IGA, FoodWorks and Miter 10 have called for a 1-year wage freeze to be imposed on retail workers, warning the coronavirus crisis could persist for at least 12 months (64)."
(AUS068) Societal—Treatment Recommendation: "Woolworths [supermarket] has suspended its online shopping in response to the shortages, while all supermarkets are limiting purchases of goods including toilet paper, hand sanitizer and non-perishable items such as pasta and rice to limit hoarding (65)."

The medical frame tended to focus on longer term preventative measures such as flattening the curve, pre-emptive school shutdowns and more robust testing regimes. This was more pronounced than the previous period and indicated the medical community's acceptance of the long-term effects of COVID-19 and it's potential to overwhelm the healthcare system as was occurring in Italy and Spain.

(AUS059) Medical—Treatment Recommendation: "We believe it is vitally important that we take swift action to reduce the number of people in close contact with others, for sustained periods of time, in order to slow the rate of COVID-19 infection," Ms. Lloyd-Hurwitz said (66)."
(SMH083) Medical—Treatment Recommendation: "Our healthcare capacity is finite. As a past president of the Australasian College for Emergency Medicine, Simon Judkins, tweeted: "Part of the pandemic plan is "hospitals opening their surge capacity". Now, I don't want to alarm anyone, but there is no surge capacity… we are full every day." Experts are working to increase that surge capacity, but this involves extraordinary measures. We can help them by slowing the surge (67)."

Negative sentiment of individuals was expressed most definitively during the "end" weeks of the study period. These moral evaluations coincided with news reports of panic buying and the first signs of epidemiological flattening of the curve. Derision of hypocritical actions as well as poor social distancing behavior were most prevalent in the moral evaluations per the Behavioral Frame.

(AUS062) Behavioral—Moral Evaluation: "Recall that memorable Twitter post of some expert standing at the microphone lecturing all of us on the dos-and-don'ts of living with a virus that is as capricious as it is dangerous. She was advising us not to put our hands anywhere near our face. Then, in order to turn the page in her notes, she stuck a finger in her mouth to wet it (68)."

TABLE 6 | Week 9 and 11, framing of COVID-19 (*n* = 234).

	Causal attribution	Moral evaluation	Problem definition	Treatment recommendation
Medical	High infection rates (R0) Person to person/close contact Weather—winter Symptoms after close contact	Triage—who gets a ventilator Elderly side-lined Dangerous situation given poor testing Healthcare workers not social distancing Fear of healthcare system overwhelmed	No vaccine developed, in testing Trials slow—ethical issues Cases/deaths increasing/reducing Demographics—vulnerable groups Impact on frontline workers—doctors/nurses Children low infection/symptoms Disaster advanced too late to stop Potential healthcare overcapacity resources finite Transmission risk—surfaces Disruptions elective surgery delay other clinical trials Flattening of curve working	Social isolation Flatten the curve Slow the spread Prepare for worse Total Isolation Pre-emptive school closures Assembly ban Hand sanitizer Testing if individual has come from oversees, fever, acute respiratory syndrome Sanitations—was hands, don't handle cash Financial aid—health services Check temperature Identify nature of super spreaders
Behavioral	Sharing kitchen utensils asymptomatic individuals not self-isolating	Disgraceful behavior in shops Hypocritical actions Self-aggrandizing Irrational actions Selfishness Flouting social isolation—beach Judgements on moralizers Armchair experts	Close contact risks ignored Self isolation for the good of the community Missing out on life Misleading information being circulated—social media Mental Health impacts of social isolation—domestic violence	Legal enforcement Random checks on individuals Fining individuals Retain social contact zoom Exercise keep mentally fit
Societal	Spread of coronavirus Pandemic Coronavirus outbreak/epidemic Virus spread from Wuhan	Slow response Panic buying Process ineffective/unprepared Gov. making good decisions/sensible Markets irrational China slow to act Poor conditions wet markets Political opportunism Calls for aid from big business obscene Careless decision making hurting business Poor media response	Economic Impacts Supply lines disrupted Job losses Global financial market Education markets Recession Opportunity investment School closures Businesses/household rents Post COVID-19 Virus timing unknown Change life as we know it—new normal Sports Canceled games TV commitments	Wage freeze, pay cuts, job losses Postponement of events Government stimulus Ban cruise ships in Aus. ports Public health act police powers Purchase limits in shops Private sectors consulting biosecurity experts Sports play without crowds, postpone 1.5m distancing, no physical contact Keep Schools open 14-day isolation ban on mass public gatherings

Shading of cells represent relative frequency of themes (white = uncommon, light gray = few instances, dark gray = common, black = very frequent occurrence).

(AUS107) Behavioral—Moral Evaluation: "Life's a beach Victorian Liberal MP Tim Smith didn't hold back after seeing footage of the covidiots at Point Addis in Anglesea, Victoria, this weekend: "I wonder if these dickheads realize they are pushing the state government into locking all of us in our houses, literally like home detention, because these tools wanted a day at the beach. Wake up—treat this disease seriously … (69)."

Moral evaluations of society tended to focus on the irrationality of sellers on financial markets and opportunism of politicians

(SMH054) Societal—Moral Evaluation: "Our modeling also suggests that if there are no further major surprises about the severity of the pandemic and markets respond in an orderly fashion, then the Australian economy would take the better part of a decade to get close to its pre-COVID-19 trajectory," KPMG says. "If the pandemic is more acute and long-lasting and businesses and consumers lose confidence, then markets could be disrupted by irrational behavior and the economic consequences could be more severe (70)."

(AUS056) Societal—Moral Evaluation: "We are just at the beginning of a pandemic and it is not time to play petty politics. If Labor has concerns it should be taking them up privately with the government, not using the virus as another opportunity to carp (58)."

Evaluations of blame/responsibility within the final "end" time period were rare as per the previous "beginning" and "middle" time periods. A retrospective word search to confirm the framing and thematic coding of "blame," "mistake," "fault," "responsibility," and their associated synonyms yielded no additional results as related to the COVID-19 pandemic. The moral evaluation frame component provided the first explicit examples of responsibility for the COVID-19 pandemic although these were exceptionally rare:

(AUS056) Societal—Moral Evaluation: "The coronavirus has been difficult to treat if only because the Chinese government refused for 2 months to advise the world that the virus was deadly and spreading quickly (58)."

(SMH022) Societal—Moral Evaluation: "We also need to remember that had the Chinese government listened to the doctor, now deceased, who warned them of a new and dangerous illness, instead of imprisoning and persecuting him, this virus might have been contained. The PM should not be persuaded that the economy and Chinese interests override our nation's health. This is not a time for appeasement (71)."

The Australian vs. the Sydney Morning Herald

There were several differences in relation to the reporting between the two newspapers. Firstly, both the Australian and the SMH newspapers began publication of the COVID-19 in late January 2020. The newspapers maintained a consistent publication rate per day until the week of the 24th February 2020. This week coincided with a dramatic increase in case numbers and also the first death in Australia (Sun, 1 March). Thereafter, the number of publications increased with the Australian consistently publishing more articles on the subject.

From the onset of COVID-19 reporting the reporting styles differed between the two newspapers. As part of the coding, Author TT allocated the newspapers to content categories such as general news or finance/business. This was a straightforward process for the SMH, where the difference between the articles was fairly well-demarcated with news reports generally objectively reporting the observations of the day and opinion pieces clearly signaling a guest author and their credentials. However, in the Australian this was not as well-defined, with many otherwise objective news reports carrying with them some element of opinion which framed the narrative. No meaningful differences were discerned between the newspapers in apportioning blame as related to the primary question of the study.

Both papers published a broad range of topics, however the SMH appeared to publish heavily on the disruption to sporting events as related to rugby league, which is predominantly based in the East Coast of Australia, where the SMH is published. The Australian published on these topics but not with the frequency, most likely indicative of their more national readership demographic.

Moralizing within the newspapers was most evident in the SMH through readers' letters and guest opinion pieces. In the Australian this was also the case however with a certain inclusion of opinion in many general news articles. For example, in an article by the Australian about panic buying, the article objectively described the effects of panic buying at particular stores in Sydney and quotations from store representatives about the disruption. However, toward the end of the document a quotation from a behavioral economist was inserted generalizing a laid-back Australian attitude as being detrimental to disaster preparedness:

(AUS047) Societal—Moral Evaluation: David Savage, an associate professor of behavioral economics at the Newcastle Business School, said Australians had a tendency to react too casually to disasters and needed to prepare more responsibly. "Australians

generally don't have the disaster plans, they don't have good survival plans," Mr. Savage told ABC News (72).

This contrasted with the SMH which typically reserved moralizing of a situation to reader's letters or opinion pieces and clearly labeled as such. For example:

(SMH022) Societal—Moral Evaluation: "His backside still smoldering from his holiday/bushfires/climate-change/sports rorts debacles, it appears our PM, now thrown into the COVID-19 melting pot, has been spurred into action. Watching Scott Morrison's COVID-19 brochure-brandishing performances reminded me of a World War II British Army instruction manual about how to react in UXB (unexploded bomb) incidents. The instruction said, "in the event of seeing a UXB officer running, try to keep up." Bill Leigh, West Pennant Hills (71)."

The overall reporting by the newspapers was objective and roughly equivalent between the two newspapers. The use of harsher language was more apparent in the Australian compared to the SMH, this was highlighted by the very occasional selective use of colorful language.

(AUS107) Behavioral—Moral Evaluation: "Life's a beach Victorian Liberal MP Tim Smith didn't hold back after seeing footage of the covidiots at Point Addis in Anglesea, Victoria, this weekend: "I wonder if these dickheads realize they are pushing the state government into locking all of us in our houses, literally like home detention, because these tools wanted a day at the beach. Wake up—treat this disease seriously … (69)"

(AUS108) Societal—Problem Definition: "[Regarding the filming of a cooking television show] Essential services? Eat your heart out, intensive care nurses! Another POO [Plate of Origin—television show] staffer texted Seven would be "lucky to get another week" of filming in. But the staffer is blunt about the network's attitude to pressing ahead with POO: "I don't think they give a shit unfortunately. Just trying to squeeze every bit of life out of something that is already dead." Ouch.

DISCUSSION

The study aimed to define where the media placed responsibility for the COVID-19 pandemic, be it explicit or not, and this discussion will concentrate on the key themes identified by the framing analysis, including the apportioning of blame. This discussion will also describe the evolution of framing of the COVID-19 pandemic by the media over the course of the study time period from when the COVID-19 pandemic was established as a potential disruptive event to the height of the epidemiological curve.

The Rise of the Wuhan Virus

Australian printed media were very slow to engage in discussion of the emerging COVID-19 pandemic. Despite the first COVID-19 case appearing as early as 1 December 2019 (30) ADDIN EN.CITE (30, 31) and whilst online reporting of an emerging influenza-type virus in the media began appearing 6 January 2020 (73), printed media picked up the story 3 weeks' later on 20 January 2020 (SMH001). For context, there were at this stage

already 204 confirmed cases and one death globally (8). Given the importance of the media in providing timely information to individuals (74), the lateness of printed media in particular to engage with the emerging pandemic and distinct lack of blame for the pandemic represents an interesting question into how the media might have interpreted the threat of COVID-19. Given recent pandemics including the H1N1 pandemic also suffered from a lack of reporting in mainstream media relative to their increasing transmission (75), an underestimation to the weighting of risk of COVID-19 by the media is implied.

Getting to Grips With the Issue

Economic risks associated with the COVID-19 pandemic were emphasized to a high degree with results showing that the overwhelming response by the media across the time periods to the escalating pandemic was related to economic disruption. As per the analysis, this was framed as a societal problem definition, with the themes of financial market turmoil and disruption to businesses pervasive throughout the study. Over the study period, the examples of social issues related to economic impacts were increased but, as might be expected, moved from a prospective view on the potential effects such as recession to a retrospective view of the cost to business and tax payers for government financial aid packages.

As with previous pandemics the highlighting of risks can serve to increase public concern and increase engagement in precautionary measures (74) and in some cases can result in irrational behaviors (76). The media highlighting discourse into the perceived risks of the COVID-19 confirms previous media studies related to Ebola (77), Zika (76), and SARS (74). However, in these examples the nature of the perceived risk was more aligned with personal health risk and therefore mortality through transmission as opposed to the fiscal risk of COVID-19 through business disruption.

The Antidote

Generally, the economic impacts of the pandemic were followed by recommendations a fiscal nature such as requests for aid, subsidies and stimulus packages. However, the dominant treatment or solution to the prevailing conditions were initially of a public health nature. At the outset, a public health response was highlighted with examples emphasizing border closures and social distancing measures but, as time progressed, quickly turned to financial solutions through economic stimulus and aid packages as called for by business and actioned by the government. Early on it was noted that a balanced public health response with respect to the economy should be actioned. These examples highlight the objective inclinations of the media to focus on "action" and "consequence" to construct their narratives as opposed to more subjective or emotional responses to the pandemic, replicating previous studies results in defining the approach of printed media to disease outbreaks (32, 75).

Pointing Fingers

Moral evaluations over the study period were varied in the tone of the response and specificity of blame was often opaque. In the beginning period, moral evaluations were largely directed

at the government and to elements of process. This was largely praise related to the government's fast response, which was highlighted as a contrast to the recent bushfire disasters where the government were seen as slow and ineffective in their response (78). Some negative sentiment surrounding confusion and disorder of process in relation to evacuation of Australian residents from Wuhan, China, were present but infrequent. Over time, further moral evaluations of the community, that might imply responsibility, became apparent but were infrequent, vague and indirect. Panic related to irrational behaviors on the financial markets was highlighted as a societal issue and dominated the moral evaluations at this point. At the "end" of the study period, which coincided with passing the peak of the epidemiological curve and therefore a slow-down in COVID case frequency, moral evaluations had increased in frequency considerably and were now more emotionally charged, including direct denigrations of poor behavior of citizens panic buying, of the triage process and who was deserving of ventilators. The bulk of the moral response was still concerned with societal issues related to financial markets. The federal government still garnered considerable praise for their actions.

Explicit blame for the COVID-19 pandemic was sparse, indirect and infrequent during the study period. While the virus was frequently depicted as originating from China, it was only at the end of the study period that direct criticism of the Chinese pandemic response was found, and even then, instances of these were very few. The disinclination to frame responsibility for the pandemic was also made apparent in some SMH articles in the beginning period, with later representations of blame primarily exemplified within readers' letters. This contrasts to the media sentiment at the time of writing (post-study period) where a significant media effort to apportion blame to China for its slow response is underway (79).

Our study has shown that, rather than allocating responsibility, the Australian media have remained objective in their reporting following common "action" and "consequence" tropes as identified in previous studies (32). Allocating blame as a method of making sense of a crisis and allaying fears is well-known (20, 34, 80). Blame is usually apportioned to geographically distant groups with the mechanisms for assigning blame often including *othering*, and is commonly used as a tool by the media as a form of reassurance in the face of crisis (80, 81). The relative absence of immediate blame during the study period represents a divergence from previous epidemics/pandemics (20). One explanation could be that, whilst othering and therefore allocation of blame to an external "actor" is a method of reassurance, the fact that blame was almost absent until the height of the epidemiological curve had passed (i.e., higher risk was over), implies that print media did not accept the risk was high enough within Australia to merit it, therefore blame was never explicit. Further, reported examples of blame occurred on the other side of the epidemiological curve and therefore when perceived risk was reduced. This is more in tune with a retrospective accounting of the pandemic and more aligned with a government inquiry or investigation rather than use as a coping mechanism. The reluctance of the media to portray responsibility is potentially justified by the nature of the risk

as it existed in Australia with low case numbers and a low case fatality rates, relative to other countries such as Italy and Spain where the health effects and associated public health response were a lot more severe (8). Another explanation could be that the blame was thought to be so obvious as not worthy of further comment, supported by the fact that the geographical origin of the virus was often reported. Alternatively, in the study period government intervention and public health directives were updating almost daily, and therefore it is possible the print media were focused on the rapidly changing societal environment and its short- and longer-term implications rather than the apportionment of blame. This is supported by the finding of greatest focus throughout all time points on the societal -problem and treatment frames, and previous literature suggesting timing and messaging by the media during times of crisis represents an important medium to manage public awareness, expectations and ultimately behavior in light of a pandemic (74).

STRENGTHS AND LIMITATIONS

The volume of articles published within the study time frame using the search terms was simply overwhelming for hand-coded framing and thematic analysis. For this reason, many other state-wide newspapers and interstitial time periods were excluded from the study to reduce sample size. Other forms of media such as social media, blogs and television were also excluded based on the same premise. These forms of media were also excluded due to the inability of being able to search and retrieve from them systematically. For these reasons representation of examples may be incomplete in answering where the media placed responsibility for the COVID-19 pandemic. The truncated study period relative to the current progress of COVID-19 also represents a limitation and was based on the data available at the time of commencement of the study. This is noted as a common limitation in the study of pandemics and given

the unknown length of many social distancing guidelines may represent a "lingering crisis" (75, 82). At the time of writing, some significant geo-political inquiries are being sought by various governments into the handling of the COVID-19 pandemic which would have potentially added further examples of how the media apportioned blame/responsibility for the pandemic (79). Overall, our study adds to the existing literature in describing shortfalls and strengths in how the media responded to framed responsibility for the COVID-19 pandemic.

CONCLUSION

Our findings provide several insights into how the media framed responsibility for the COVID-19 pandemic of 2019/2020. The distinct lateness in publications related to COVID-19 and the lack of blame potentially represents an indication of how the media have interpreted the risk as posed by the COVID-19 pandemic in Australia. The perceived risk by the media may be justified based on confirmed cases and total deaths in Australia relative to other affected countries.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

AUTHOR CONTRIBUTIONS

TT collected the data and undertook the data analysis. AW and ET reviewed the data analysis. TT wrote the first draft of the manuscript and all authors participated in the development and editing of the manuscript, including the final approval. All authors contributed to the design of the study and its analytical approach.

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Monitoring Covid-19 Policy Interventions

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A very key point in the process of the Covid-19 contagion control is the introduction of effective policy measures, whose results have to be continuously monitored through accurate statistical analysis. To this aim we propose an innovative statistical tool, based on the Gini-Lorenz concentration approach, which can reveal how well a country is doing in reducing the growth of contagion, and its speed.

Keywords: concentration curve, contagion growth, statistical models, reproduction rate number, health policy interventions

1. INTRODUCTION

Coronavirus disease (Covid-19) is a novel coronavirus which causes severe respiratory illness (1). The first cases of pneumonia cases of unknown etiology, later ascribable to the new Covid-19, arose at the end of December 2019 in Wuhan, the capital city of Hubei (China), and later in other Asian countries, such as Korea and Iran. On 21 February 2020, the first cases were recorded in Italy and from there on the contagion rapidly extended, to other European countries (especially Spain, United Kingdom, France, and Germany) and, later, to the whole world (including the United States, Russia, and Turkey).

As no specific vaccine is yet available, all governments attempted to control the spread of the pandemic phenomenon. Extensive health policy measures were implemented with the purpose of reducing the person-to-person transmission of the virus.

To be effective, policy measures need an effective continuous monitoring of their results. In this respect, recent studies on policy monitoring were addressed to the study of Covid-19, both from an epidemiological and a statistical view point [see e.g., (2)].

The contribution of this paper is in this latter direction. One quadrimester after the outbreak of the pandemic in China, and one quarter after its worldwide spread, it becomes important to compare the containment policies undertaken by the different governments, to learn which have been most effective, and draw lessons for the management of the subsequent phase, which may include a possible relaxation of the measures, and a more strict statistical monitoring of their results. We propose an innovative statistical tool which can assess the effectiveness of policy measures in the containment of the Covid-19 contagion growth over time. This because the most important effort during the outbreak has been the reduction of the number of infected people which, in turn, determine a reduction in the severely hospitalized patients and, ultimately, a reduction of deaths.

The proposed tool has the purpose to detect the countries which achieved the best results in terms of reduction in number of contagions in the smallest time interval. An accurate analysis of the Covid-19 dynamics along the weeks can provide useful information to improve health policies and reorganize the related services. It is also very useful to plan future interventions, in case of new contagion outbursts.

The paper is organized as follows: Section 2 is devoted to the illustration of our proposal; Section 3 reports the results based on data concerning the Covid-19 cases detected in periods of about 2 months (9 weeks) in the time span between 20 January 2020 and 22 March 2020 in China and between 24 February 2020 and 26 April 2020 in Italy, Germany, Korea and USA; Section 4 concludes the paper with final comments.

2. PROPOSAL

Most epidemiologic models, including the well-known Susceptible-Infected-Recovered (SIR) model [see e.g., (3, 4)] rely on the assumption that contagion counts Y can be well-explained by a function of X, (time) such as a linear, exponential, or logistic, indicating different growth patterns. To understand which function of X best fits Y, quantitative concordance measures taking time into account are needed. We propose to employ a method which uses a rank-based quantitative measure, extending what proposed in the predictive accuracy context by Giudici and Raffinetti (5) and Agosto et al. (6).

Let $P_c = \{p_{c_1}, \ldots, p_{c_n}\}$ denote the positive cases of Covid-19 and D the day of the occurred contagion, such that $D = \{1, \ldots, n\}$. We can then build a curve C, according to Agosto et al. (6), as follows:

- re-order the P_c variable values by the ranks of variable D and denote them with $p_{c_{r(d_i)}}$, where $i = 1, \ldots, n$ and $r(\cdot)$ represents the rank;
- determine the curve C coordinates, i.e., $(i/n, (1/(n\bar{p}_c)) \sum_{j=1}^{i} p_{c_{r(d_j)}})$, where $\bar{p}_c = \frac{1}{n} \sum_{i=1}^{n} p_{c_i}$ and $p_{c_{r(d_j)}}$ is the j-th P_c variable value ordered by the rank of the corresponding d_j value (with $j = 1, \ldots, i$);
- provide the set of the linear curve points of coordinates $(i/n, i/n)$.

The C curve is a *concordance curve* since it measures the concordance between the ranks of the P_c variable values $r(p_{c_i})$ and the ranks of the D variable $r(d_i)$, for $i = 1, \ldots, n$. Based on the C curve behavior, five main scenarios may arise: (a) a perfect concordant relationship between the Covid-19 positive cases P_c and time D, which occurs iff $r(p_{c_i}) = r(d_i)$ for any $i = 1, \ldots, n$; (b) a perfect discordant relationship between the Covid-19 positive cases P_c and time D, which occurs iff $r(p_{c_{n+1-i}}) = r(d_i)$ for any $i = 1, \ldots, n$; (c), (d) a partial discordant and then concordant relationship or a partial concordant and then discordant relationship between the Covid-19 positive cases P_c and time D, which occur iff the P_c variable ranks are partly discordant and partly concordant with the D variable ranks; (e) a uniform relationship between the Covid-19 positive cases P_c and time D, which occurs iff the number of Covid-19 positive cases uniformly increases over time, i.e., $p_{c_i} = p_{c_j}$ for any $i = 1, \ldots, n$ and $j = 1, \ldots, n$, so that $p_{c_i} = p_{c_j} = \bar{p}_c$, being $\bar{p}_c$ the mean of positive Covid-19 cases.

As an example, the graphical representation of the C concordance (in blue) curve and the linear (in black) curve, corresponding to the bisector curve of the unit side square, is reported in **Figure 1**.

Figures 1A–E display the Covid-19 spread over time, in the cases where $r(p_{c_i}) = r(d_i)$ for any $i = 1, \ldots, n$; $r(p_{c_{n+1-i}}) = r(d_i)$ for any $i = 1, \ldots, n$; $r(p_{c_{n+1-i}}) = r(d_i)$ and $r(p_{c_i}) = r(d_i)$ for some $i = 1, \ldots, n$; $r(p_{c_i}) = r(d_i)$ and $r(p_{c_{n+1-i}}) = r(d_i)$ for some $i = 1, \ldots, n$; $r(p_{c_i}) = r(\bar{p}_c) = r(d_i)$ for any $i = 1, \ldots, n$.

To have a picture of the Covid-19 spread, daily contagions (variable P_c) can be re-ordered by time (variable D) to show if the number of contagions increases, decreases or remains stable over time. Specifically, if the concordance curve is below the bisector curve, the number of contagions increase with time whereas if the concordance curve is above the bisector curve, the number of contagions reduces with time.

Due to its features, the concordance curve can be exploited to summarize the "distance" between the P_c and the D values, in terms of the "discrepancy" between their corresponding ranks. A summary index, pointed out with RG (acronym of Rank Graduation), can be introduced as

$$RG = \sum_{i=1}^{n} \frac{\left\{ (1/(n\bar{p}_c)) \sum_{j=1}^{i} p_{c_{r(d_j)}} - i/n \right\}}{i/n} = \sum_{i=1}^{n} \frac{\left\{ C(p_{c_{r(d_j)}}) - i/n \right\}}{i/n},$$

(1)

where $C(p_{c_{r(d_j)}}) = \frac{\sum_{j=1}^{i} p_{c_{r(d_j)}}}{\sum_{i=1}^{n} p_{c_i}}$ is the cumulative of the (normalized) P_c variable values.

Note that the measure in Equation (1) is similar to that proposed in (6). The RG is equal to 0 in the case of a perfect overlap between the C concordance curve and the bisector curve: this reflects that the epidemic is under control, with the number of cases increasing at a constant rate.

When the concordance curve is below the bisector curve, the number of contagions increases with time, leading to a negative RG value. When the concordance curve is above the bisector curve, the number of contagions reduces with time, leading to a positive RG value.

The dynamics of contagion may vary over time and an analysis of the RG trend in different time intervals may be useful to better understand the most problematic periods as well as the time in which a change in the increase or decrease of cases arises. As the overall RG measure is proportional to the area between the concordance and the bisector curves, the measure of the RG variation over time, associated with a specific time interval $[t_{h-1}, t_h]$ with $h = 1, \ldots, H$, can be determined multiplying the RG index by the area between the concordance and bisector curve corresponding to the time interval $[t_{h-1}, t_h]$.

3. RESULTS

In this section we apply the concordance curve and the associated summary RG measure to assess the Covid-19 dynamics in the most infected countries in the world. The analyzed data report the daily number of positives cases[1] along a time interval of nine weeks (63 days), starting from day 24 February 2020 until day 26

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[1]Note that we do not resort to the standardized data (number of Covid-19 positive cases/number of population), since the proposed RG measure is invariant with respect to this kind of data transformation. Indeed, if the term $C(p_{c_{r(d_j)}})$ in Equation

FIGURE 1 | The Covid-19 dynamics behavior in scenarios **(A–E)** in terms of concordance curve.
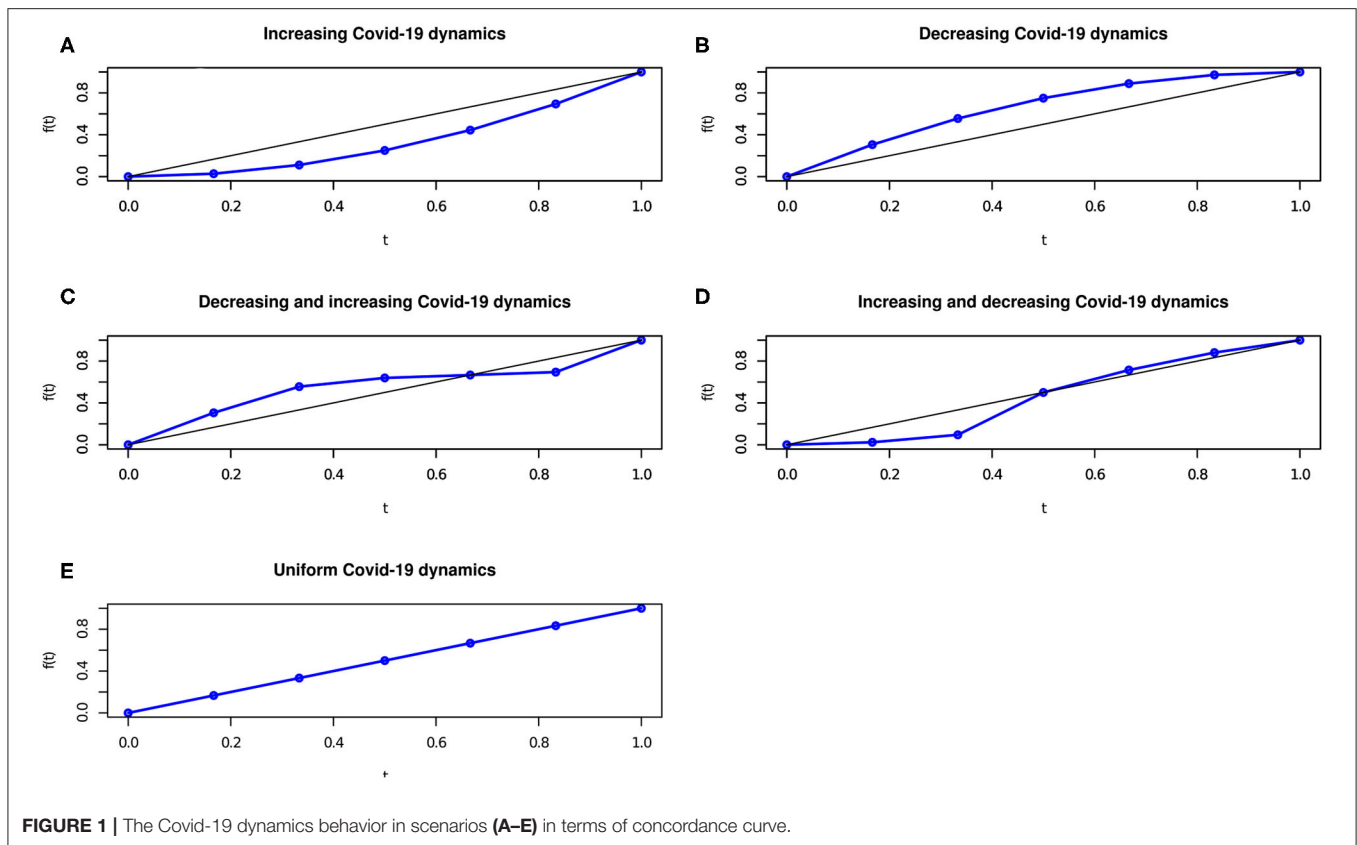
April 2020. This time interval was taken into account for both European and non European countries, except for China, where the contagion already occurred in January 2020. To provide a coherent comparison of the Covid-19 spread, we focus on the first nine weeks of Covid-19 spread in China, corresponding to the time range between 20 January 2020 and 22 March 2020.

Figure 2 presents the results of our methodology, in a graphical representation, for the considered European and non European countries.

We recall that the more the concordance curve in **Figure 2** approaches the bisector curve, the more the growth of contagions become uniform over time. From **Figure 2** it seems that Italy moved to a linear trend ahead than Germany. In other words, although Italy started with a very high number of cases, its policy containment measures have been quite effective in rapidly bringing down an exponential growth to a linear one.

We need a more thorough understanding of the concentration dynamics along time. A notable effect concerns Germany, whose area appears similar (or slightly higher) than Italy but which shows, in recent times, a growth that is less than linear (above the bisector curve), indicating that this country is doing quite well in containing the virus.

Moving to non European countries, **Figure 2** clearly shows how, on the basis of the analyzed official data, China rapidly brought down contagion numbers: its concentration curve started with a strongly increasing Covid-19 pattern, rapidly followed by a reduction in the number of cases, along the nine weeks between 20 January 2020 and 22 March 2020. Even better, Korea in the 9 weeks between 24 February 2020 and 26 April 2020 has first a linear growth, which translate into a decreasing one, while the USA presents a concordance curve behavior always below the bisector curve.

We now move to the summary statistical representation of our results, by means of the proposed *RG* measure. Before looking at that, we present some context summary statistics, which indicates the incidence of the contagion and the incidence of tests, in the considered countries, as of July 2020. The incidence is calculated as the total number of observed cases (or of performed tests) divided by the country's population. **Table 1** presents the results.

From **Table 1** note that, in population relative terms, the USA reports the highest incidence (at almost 0.9%), even though the virus outbreak was observed later, followed by Italy (around 0.4%), then Germany (around 0.2%), Korea (around 0.02%), and China (around 0.006%). The testing rate is quite in line with the incidence, with the USA first, followed by Italy, Germany, China and, finally, Korea.

We now compare countries in terms of the summary *RG* measure. **Table 2** presents the overall *RG* measure for each

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(1) is divided by the number of population n_{pop}, it results that $C(p_{c_{r(d_j)}}) = \frac{\sum_{j=1}^{i} \frac{p_{c_{r(d_j)}}}{n_{pop}}}{\sum_{i=1}^{n} \frac{p_{c_i}}{n_{pop}}}$ which exactly returns $\frac{\sum_{j=1}^{i} p_{c_{r(d_j)}}}{\sum_{i=1}^{n} p_{c_i}}$.

FIGURE 2 | The concordance curve behavior for Italy, Germany, China, Korea, and USA.
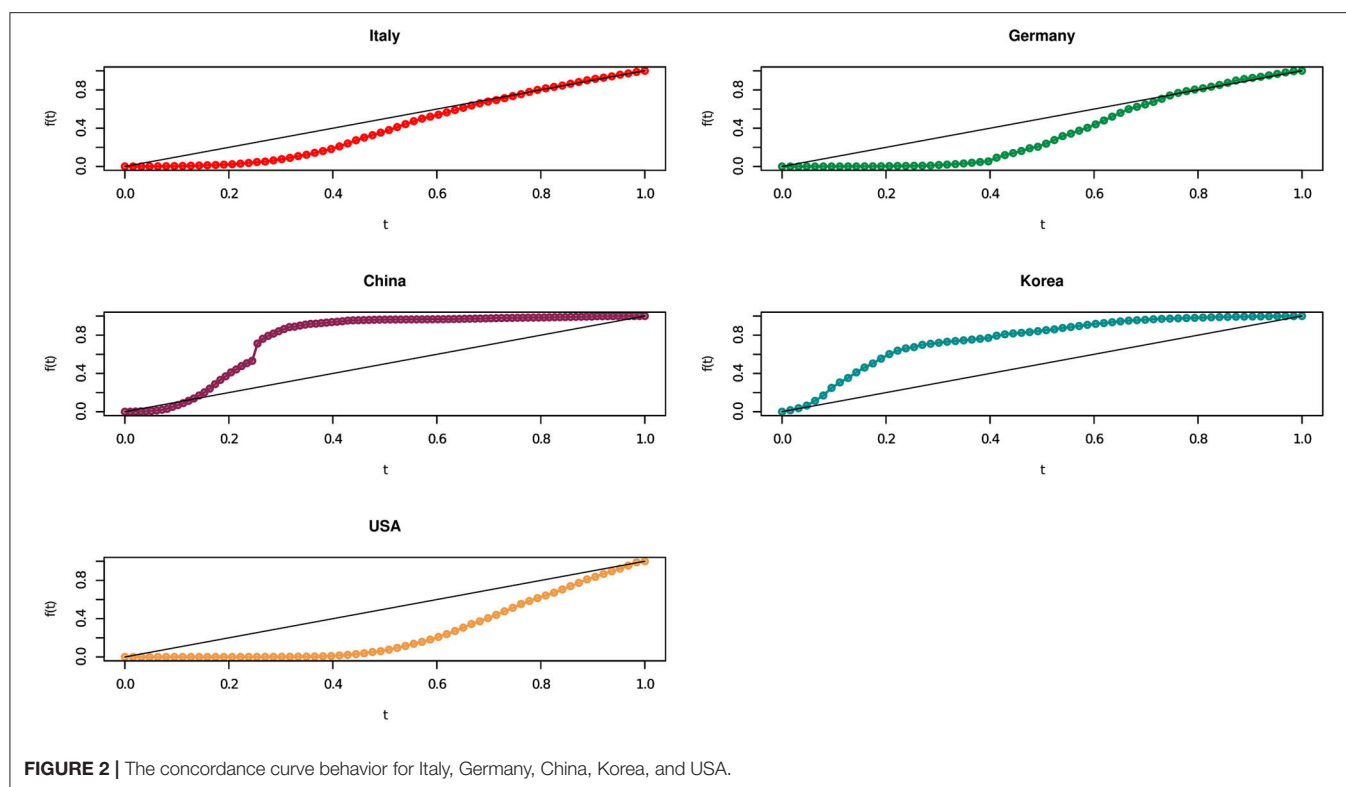
TABLE 1 | Incidence by country and test rate.

Country	Population	Covid-19 cases	Incidence (%)	Test rate (%)
Italy	60,359,546	240,961	0.398	9.09
Germany	82,366,300	196,738	0.234	7.01
China	1,433,783,686	83,542	0.006	6.28
Korea	60,359,546	12,967	0.025	2.55
USA	329,311,764	2,854,976	0.862	10.75

TABLE 2 | *RG* value by country.

Country	*RG*
Italy	−24.56
Germany	−31.52
China	+10.07
Korea	+52.48
USA	−41.66

TABLE 3 | *RG* variation over time and R_0 (China)—Week 1: 20 January 2020 to 26 January 2020; Week 2: 27 January 2020 to 2 February 2020; Week 3: 3 February 2020 to 9 February 2020; Week 4: 10 February 2020 to 16 February 2020; Week 5: 17 February 2020 to 23 February 2020; Week 6: 24 February 2020 to 1 March 2020; Week 7: 2 March 2020 to 8 March 2020; Week 8: 9 March 2020 to 15 March 2020; Week 9: 16 March 2020 to 22 March 2020.

	China	
Week	**RG variation**	**R_0**
Week 1	−0.35	-
Week 2	−0.57	7.00
Week 3	+0.28	1.84
Week 4	+1.87	1.37
Week 5	+2.90	0.27
Week 6	+2.51	0.34
Week 7	+1.90	0.30
Week 8	+1.15	0.20
Week 9	+0.38	1.94
Overall *RG*	+10.07	

country, indicating how fast the incidence observed in **Table 1** has grown, and how fast it has been contained.

Table 2 clearly shows that Korea, followed by China, are the best performing countries: in both cases the curve has been below a linear growth trend for most of the time. In line with our comments to **Figure 2** the two countries are followed by Italy and Germany, which managed to bring down their large numbers thanks to very severe containment policies (Italy) or extensive testing (Germany). Last, the curve of the USA shows a still persistent difficulty in pandemic control.

As mentioned several times, to compare policies, it is important to understand how the *RG* measure has evolved over time, in each country. The results of the *RG* variation over time are shown in **Tables 3**, **4**.

From **Table 3**, note that China moved from a negative to a positive *RG* value already during the third week from the reported outbreak, highlighting that the contagion was contained rather promptly. Moreover, in the fifth week the *RG* reaches the highest

value denoting the greatest decreasing reduction in number of Covid-19 positive cases over time.

Italy and Germany (**Table 4**) record positive RG values only during the latest two weeks. The presence of this RG positive value is due to the fact that the trend of contagion becomes stable overtime, indicating that the countries have reached a contagion peak. It is worth noting that the RG associated with Germany in the last week takes a greater value than that of Italy. This results is consistent with the fact that between the 56-th and 63-th days the Germany concordance curve starts lying slightly above the bisector curve. These findings indicate that Germany has been able to contain the contagion, and so has Italy, which however started before and had higher contagion counts.

Consider now the situation in non-European countries. From **Table 4**, note that Korea always reveals a positive RG value for the whole time-interval. More precisely, in the first days of the first week, the number of contagions uniformly increase while in the remaining time it follows a decreasing trend. This indicates a very effective containment policy, sustained by a high level of testing as shown in **Table 1**. On the other hand, USA do not record a reversal of the contagion trend overtime. This may indicate a late start but also a less effective containment policy.

To gain further insight into the advantages of our proposal, we present a comparison of the RG measure with the reproduction rate (number) R_0. We recall that the reference epidemiologic model, the Susceptible Infected Recovered (SIR) methodology [see, for example, (2)] is essentially based on the determination of R_0, calculated as:

$$R_0 = \frac{b * (1 - a) * E(T)}{h} \qquad (2)$$

where, for any individual in a population: b is the probability of becoming infected (infection rate); $E(T)$ is the mean incubation time of the disease, in case of infection; h is the probability of detecting the infected case (confirmation rate); a is the probability of isolating the contacts of the infected case (quarantine rate). Using what available in the SIR modeling literature, Agosto and Giudici (2) proposes how to set these parameters to study a possible evolution of the Covid-19 outbreak: T is based on a Gamma distribution, with expected value equal to $E(T) = 7.5$, $1 - a$ is set equal to h, without loss of generality; and b is estimated from a statistical model: exponential (as in standard SIR models) or autoregressive [as in (2)]. Here we will follow a non parametric approach, according to which b can be calculated as the ratio between the new observed cases $\hat{\gamma}_t$ at t and the mean number of observed cases in the previous $(t - l, \ldots, t - 1)$ days. In line with the expected infection time (7.5 days for Covid-19), l is fixed equal to 7, so that:

$$\hat{b} = 7 * \frac{\hat{\gamma}_t}{\sum_{i=t-l}^{t-1} \hat{\gamma}_i} \quad \text{with:} \quad i = 1, \ldots, t - 1; l = 1, \ldots, 7. \quad (3)$$

Following the previous step, a baseline level of R_0 can be calculated as follows:

$$R_0 = E(T) * \hat{b} \qquad (4)$$

TABLE 4 | RG variation over time and R_0 (Italy, Germany, Korea and USA)—Week 1: 24 February 2020 to 1 March 2020; 2 March 2020 to 8 March 2020; Week 3: 9 March 2020 to 15 March 2020; Week 4: 16 March 2020 to 22 March 2020; Week 5: 23 March 2020 to 29 March 2020; Week 6: 30 March 2020 to 5 April 2020; Week 7: 6 April 2020 to 12 April 2020; Week 8: 13 April 2020 to 19 April 2020; Week 9: 20 April 2020 to 26 April 2020.

Week	RG variation	R_0
Italy		
Week 1	−1.61	-
Week 2	−4.54	4.53
Week 3	−6.47	3.21
Week 4	−6.31	2.12
Week 5	−3.89	1.20
Week 6	−1.67	0.83
Week 7	−0.47	0.86
Week 8	+0.21	0.86
Week 9	+0.19	0.82
Overall RG	−24.56	
Germany		
Week 1	−1.43	-
Week 2	−4.25	7.67
Week 3	−6.87	4.01
Week 4	−8.33	5.99
Week 5	−6.89	1.76
Week 6	−3.78	1.26
Week 7	−0.73	0.73
Week 8	+0.36	0.68
Week 9	+0.40	0.68
Overall RG	−31.52	
Korea		
Week 1	+1.25	-
Week 2	+6.62	1.08
Week 3	+8.88	0.30
Week 4	+8.13	0.80
Week 5	+7.36	0.84
Week 6	+6.54	0.99
Week 7	+5.17	0.40
Week 8	+3.25	0.54
Week 9	+1.11	0.45
Overall RG	+48.31	
USA		
Week 1	−1.09	-
Week 2	−3.27	10.71
Week 3	−5.43	6.92
Week 4	−7.42	9.45
Week 5	−8.37	4.11
Week 6	−7.50	1.92
Week 7	−5.14	1.16
Week 8	−2.77	0.94
Week 9	−0.67	0.84
Overall RG	−41.66	

which, assuming $E(T) = 7.5$, gives $R_0 = 7.5 * \hat{b}$. Epidemiologically, the higher the R_0 the higher the number of people that will be infected and, eventually, will be hospitalized in severe conditions, or will die. A value of R_0 less than 1 indicates that the epidemic is under control, and is leading to an upper bound of cases. From our proposed definition of b, it is clear that policy making (and its compliance) can affect it by changing a, h, or both.

In our perspective, we refer to weekly intervals, leading formula of R_0 becoming $R_0 = \frac{\hat{\gamma}_w}{\hat{\gamma}_{w-1}}$, where $\hat{\gamma}_w$ and $\hat{\gamma}_{w-1}$ represent the total new Covid-19 positive cases observed in week w and in week $w - 1$, respectively. It follows that the value for R_0 is not available for the first week.

The results of our weekly R_0 are shown in **Tables 3**, **4**, and can be compared with those of the RG values, for all weeks except the first. The overall trend of R_0 confirms that of the RG statistics, with very low values for Korea, fast decreasing values for China, slowly decreasing values for Italy and Germany and even slower for the USA. However, the R_0 appears more suitable to indicate "local" variations rather than to evaluate policies in a longer time horizon. This is shown, for example, in the case of China, in which Week 9 indicates a rebound of the R_0, due to the emergence of a relatively small number of cases, but large with respect to the cases of the previous week. This does not indicate that the containment policy is failing but rather a "warning sign."

4. CONCLUSIONS

We have presented a novel methodology that can be very helpful to summarize and compare the effectiveness of Covid-19 containment measures, in different countries. Specifically, we have applied our proposed measures to the most infected world countries, in order to assess if an increasing, uniform or decreasing relationship occurs between the number of positive Covid-19 cases and time.

Our empirical findings show that, starting from 13 April 2020, Italy and Germany have achieved at least a uniform or slightly decreasing trend of the contagion dynamics. With regard to the non-European countries, China and Korea appear as the most effective in containing the contagion, while USA do not perform well due to an evident spread in the number of contagions.

Future research may involve comparison of other components of the disease epidemiology, such as the number of severely hospitalized people, and the number of deaths.

DATA AVAILABILITY STATEMENT

Publicly available datasets were analyzed in this study. This data can be found here: https://www.who.int/emergencies/diseases/novel-coronavirus-2019/situation-reports.

AUTHOR CONTRIBUTIONS

This paper is the result of a close collaboration between the two authors. However, PG wrote sections Introduction and Conclusions and ER wrote sections Proposal and Results. Both authors contributed to the article and approved the submitted version.

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SUPPLEMENTARY MATERIAL

All used data are publicly available at the WHO website. Data analysis was made using the R package, and the employed code is available upon request from the authors.

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Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Political Consequences of COVID-19 and Media Framing in South Korea

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This study explored the Korean media's framing of COVID-19 and its impact on people's support for the government. A disaster such as a public health crisis has political consequences. COVID-19 is no exception. However, the direction of the effect is not easily determined. To properly understand this phenomenon, it is necessary to analyze how the media frames the crisis. Using Structural Topic Model, this study examines the Korean media's framing of COVID-19 and especially pays attention to international comparative framing. Based on our analysis results, we argue that expanded framing, which compared the quarantine performance of Korea and other countries, induced a positive change in people's attitudes toward the government, leading to a major political victory for the ruling party in the legislative election. Our research not only identifies the impact of international comparative framing on government support but also contributes to the development of methods for measuring media framing utilizing topic modeling methods.

Keywords: COVID-19, framing, structural topic model, media, public health crisis

INTRODUCTION

Disasters have political consequences, and the COVID-19 pandemic is no exception. Under the pandemic, we can see an increase in the approval ratings of political leaders in several countries, including Italy, where rates of infection and deaths were exceptionally high. By contrast, the American president's approval rating remains steady, and Japan's prime minister faces a slight decrease in his approval rating [1]. In South Korea, not only President Moon Jae In's approval rating increased under the COVID-19 pandemic, but also the increase led to a landslide victory of the ruling party in the legislative election. The result drew much attention from around the world because it was the first nationwide election held during the pandemic. The ruling Democratic Party earned 180 seats out of 300 the largest victory in the history of legislative elections in South Korea.

What makes the difference? When does a disaster induce an increase in a political leader's approval rating, and when does it diminish it? The most intuitive explanation is that political support is associated with government performance in protecting citizens from the disaster. This logic seems to explain the Japanese case, in which political support for the incumbent decreased as doubts grew about the government's ability to control COVID-19. However, this does not explain the Italian case, in which a rise in political support appeared, even though government performance in controlling COVID-19 was relatively weak. Another common explanation is the so-called "rallying 'round the flag" effect [2], meaning that people rally around the government during crises such as war. This effect

could explain the Italian case, but it does not explain the American and Japanese cases.

We suggest that more complicated and subtle political activities are at work, in addition to government performance. Among them, we focus on frame setting by the media. A disaster such as the COVID-19 pandemic has various aspects, and the parts the media choose to highlight, that is, how the media frame COVID-19, can determine people's responses to the threat. For example, if the media emphasize the role of the government and the need for national consensus in the COVID-19 crisis, rather than the objective performance of health policy, and if this approach earns public favor, the "rallying 'round the flag" effect could emerge. On the other hand, if the media emphasize international comparisons of various countries' disease control policy performance and present a vivid picture of a specific government's poor performance, the framing could induce a decrease in approval ratings. As framing theories and studies employing them have already claimed, both the actual threat and the way it is described are important (3, 4).

By exploring the COVID-19 framing features and changes in Korean media, we will analyze their impact on the Korean government's approval rating. There are two main reasons we selected the Korean case for analysis among many other countries. (1) In Korea, there was not only a rise in approval ratings but also a landslide victory for the ruling party in the legislative election. The analysis value is high because changes in approval ratings led to changes in the political power structure. (2) We pay particular attention to the international comparative frame of the Korean media and hypothesize that it would have had a great impact on the government's approval rating. As COVID-19 has demonstrated, the crisis caused by the virus crossed borders, meaning that international comparative framing could easily appear in other countries as well as in Korea. An analysis of the Korean case could contribute to the understanding of the political effects of international comparative framing in other countries.

The study's research questions are as follows:

(1) How was COVID-19 framed by the media in Korea?
(2) What is the feature of framing emphasizing international comparisons?
(3) How has this framing affected the Korean government's approval ratings?

MATERIALS AND METHODS

Data Collection

We collected articles related to COVID-19 from 11 representative national daily newspapers in Korea. We used a database named "BigKinds" (https://www.bigkinds.or.kr/), which is run by the Korea Press Foundation and provides data on articles in Korea's leading 11 national daily newspapers. We collected all the items produced from January 20 to April 14, including the keyword "corona" in Korean (코로나). We used "corona" as our search term because it is the most natural and comprehensive word for referring to COVID-19 in Korea.

The reasons for establishing the period from January 20, 2020, to April 14, 2020, are as follows: On January 20, the first patient was confirmed to have been diagnosed with COVID-19 in Korea. From this point on, the framing of COVID-19 began in earnest. April 14 was the day before the legislative election in South Korea. Since the rise in support for the government was vividly revealed on the day of the election, we decided to examine public opinion and framing until just before the legislative election.

More specifically, we used a list of words in articles as data. BigKinds does not provide the original text of the item. Instead, it provides words that appear in each piece. For example, let us assume that a newspaper article's text body is as follows: "At today's meeting of the World…" In this case, BigKinds will produce a list of words in the article including "At, Today, Meeting, World…" This type of data is suitable for use in topic modeling methods such as the structural topic model (STM), which we used. We excluded duplicate articles from the initial search results. Newspaper companies sometimes republish the same article with only slight changes to a word or phrase, but such duplicate items were unnecessary in our analysis. We therefore removed articles that BigKinds categorized as repeated articles. However, because BigKind's information is incomplete, we checked whether the first and last 50 characters in the list of words for each article were the same. If we found duplication in either part, we removed the item. Finally, 37,184 articles were used as data.

METHODS

Our main method was STM, a type of topic modeling method, which, in addition to the essential function of such methods to estimate multiple topics from large quantities of documents, estimates changes in the proportion or content of the estimated topics according to the meta-information of the documents (5, 6). Meta-information in a document refers to various information belonging to the document other than the content of the document, e.g., document publication time, document category. We utilized the publication time and type of newspaper as key meta-information to estimate the changes in the proportions of topics statistically. Estimating topics from 37,184 articles with STM makes it possible to analyze main subjects or framings more objectively and efficiently.

TABLE 1 | Newspapers and their categories.

Newspaper name	Category
Chosun-ilbo	Conservative
Joongang-ilbo	Conservative
Donga-ilbo	Conservative
Hankyoreh	Liberal
Kyunghyang Shinmun	Liberal
Kookmin-ilbo	Other
Naeil Shinmun	Other
Munhwa-ilbo	Other

TABLE 2 | Topics and topic communities.

Topic #	Interpretation	C#
6	Museum events (e.g., online exhibitions)	1
9	COVID-19-related gossip of celebrities	1
10	COVID-19 and fine dust or atmospheric conditions	1
14	Rent reduction campaign to overcome COVID-19	1
19	Donations to overcome COVID-19	1
22	Interruption of church services	1
26	Disputes concerning event and travel cancellation penalties and related government policy	1
29	News on farmers and sales of agricultural products during the COVID-19 crisis	1
32	Prosecutors' investigations and court rulings	1
33	News on various broadcast programs and shows	1
34	Issues related to mask supply (prevention of hoarding, supply increase, etc.)	1
36	Dramatic stories of families that occurred because of COVID-19	1
39	Political conflict over various remarks, including hate speech related to COVID-19	1
40	News presenting a quiet street scene	1
43	COVID-19-related conferences with the president	1
44	Online consumption growth and distribution industry	1
46	News relating to prayer or sermons	1
48	Introduction of various self-defense methods focusing on disinfection methods	1
62	Film and film industries	1
69	Closure of various facilities for quarantine	1
70	News about how to relieve depression or anxiety caused by COVID-19	1
72	News of investigations into false information and rumor dissemination	1
79	Reviews of society and the world written in consideration of COVID-19	1
5	The effect of COVID-19 on the air transport industry	2
16	Suspension of factory operations due to COVID-19 (Hyundai Motor, etc.)	2
20	Changes in the working form of companies due to COVID-19 such as telecommuting	2
25	Changes in economic indicators such as exports due to COVID-19	2
30	News on economic prospects	2
42	Government regulations relating to employment and labor-related issues arising from COVID-19	2
50	The financial performance of major companies and their stock price prospects	2
52	Development of mobile application related to COVID-19 and support for the development	2
58	Lack of blood supply due to COVID-19 and group blood donation	2
61	New vehicle launches and sales situation	2
65	News on the stock market	2
71	News on the government's extra budget	2
75	News on major companies (stories of CEOs, etc.)	2
76	Policies to support small business owners and small- and medium-sized enterprises affected by COVID-19	2
78	Financial support policies for companies such as loan support	2
4	Dr. Li Wenliang's death and President Xi Jinping's weakening political base	3
7	COVID-19-related news on major cities in China such as Wuhan	3

(Continued)

TABLE 2 | Continued

Topic #	Interpretation	C#
17	Events and conflicts related to quarantine facilities for Korean residents in Wuhan	3
21	COVID-19 in the United States and the U.S. Government's response	3
24	The novel coronavirus generation process and infection path (including a description of the Chinese region)	3
28	U.S. political news	3
37	COVID-19 confirmed patient statistics (many news reports from China)	3
38	Efforts to develop vaccines and treatments for COVID-19	3
45	COVID-19 reaction of U.S. forces in Korea and South Korean forces	3
49	COVID-19-related situations in Italy and other European countries	3
51	News on bans to entering countries	3
54	COVID-19 infection of political leaders in other countries	3
56	News on North Korea	3
59	News on games	3
60	COVID-19 patient occurrence news	3
63	International relations and diplomatic news	3
64	COVID-19 collective infection of Japanese cruise ship passengers	3
73	News on Japan (e.g., Prime Minister Abe)	3
27	Postponement of school openings, academic schedule adjustments, and other related issues	4
47	Colleges' COVID-19 reactions, including the postponement of the opening of classes	4
77	News of the closure of childcare institutions and private education institutions	4
23	Deferring and canceling major sporting events, including the Tokyo Olympics	5
35	Golf tournament news	5
57	Sports news	5
1	News about the Sincheonji church	6
2	COVID-19 news from Daegu	6
3	Symptoms and numbers of confirmed or infected patients	6
8	Various policies to prevent infection (e.g., social distancing)	6
12	News of deaths from COVID-19	6
15	Collective infection cases and patient news (care centers, Zumba dance academies, PC rooms)	6
31	Confirmed patients' contact tracing	6
41	Responses and activities of various government ministries and local governments with respect to quarantine	6
53	The hospital and medical staff situation (lack of beds, the fatigue of medical staff)	6
55	News of domestic patients or confirmed patients	6
66	COVID-19-related news on Jeju	6
67	COVID-19 test results (including those of key politicians and other important people)	6
68	News on confirmed patients from various locations	6
74	Various measures to prevent collective infection at work (such as measures to prevent infection of call-center staff)	6
11	News of the April 15 legislative election	7
13	News of each political party (mainly on the legislative election)	7
80	Issues of voting in general elections such as pre-voting	7
18	Prices of apartments and real estate falling due to COVID-19	8

The process of estimating multiple topics from a large number of documents using topic modeling methods is based on several assumptions. Most of the topic modeling methods developed after latent Dirichlet allocation (LDA), the most commonly used topic modeling method (7), share these assumptions and processes. First, a document is assumed to be a "bag of words," and only information about the frequency and type of each word is utilized, not the actual sentence. This assumption is the reason we can fit our model with word list information from each newspaper article in BigKinds without the original text. Second, a topic is assumed to be a probability distribution of words. In this probability distribution, a word that is important for a topic has a high probability, while a word that is not has a low probability. This assumption is reasonable, given that a topic is realized in language material through an unequal use of words. For example, the topic "Banning foreigners from entering the country" can be written as a probability distribution of words such as [foreigners−0.02, entry−0.01, prohibition−0.01, border−0.009…]. Third, it is assumed that each document is generated from multiple topics and a probability distribution of the topics unique to each document. The distribution of topics held by a document refers to the proportion of multiple topics in that document. For example, if three topics were estimated in the entire document, one document could have a topic distribution such as [Topic 1–0.4, Topic 2–0.4, Topic 3–0.2]. This is also a reasonable assumption, given that a single document—in this case, a newspaper article—can have a variety of topics simultaneously.

Topic modeling methods after LDA, including STM, estimate topics (i.e., probability distributions of words) and document-specific topic distributions that are most likely to generate given documents (8, 9). Extracting topics from documents has become a statistical problem, as documents are viewed as bags of words, and the topic is assumed to be a probability distribution of words. Specific estimation algorithms vary, and algorithms such as Gibbs sampling and variational inference are the best known (8, 10).

We propose that topics from topic modeling methods are valuable for analyzing framing, which is why we utilized STM. According to framing theory, the critical features of framing are selection and salience. In other words, selecting specific aspects and making them salient is framing (3, 11, 12). If we pay attention to a set of words with a high probability from an estimated topic, we can deduce the most salient objects in the given data because it is natural that important and salient objects are frequently referred to. Moreover, a set of words with a high probability also provides information on the context of important objects. It is difficult to understand the meaning and value of an object from just one word referring to the object. However, if we have a set of high probability words, we will be able to infer the context in which they are used, and we can more accurately estimate the nature of the objects. For example, when the word "Japan" has a high probability, it is difficult to know exactly
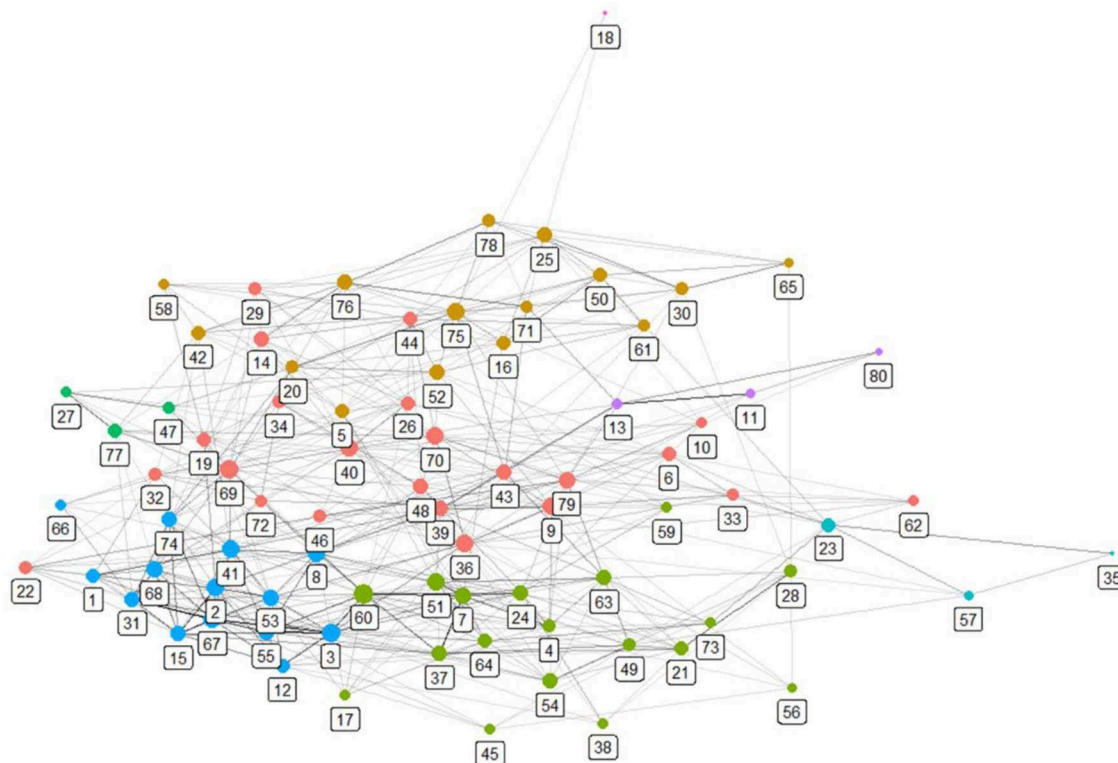
FIGURE 1 | Topic network.

what it means. However, if words such as "colonial land," "trade," "conflict," "Korea," and "revenge" also have a high probability, the meaning and value of the object "Japan" is more apparent in the data. In a nutshell, a topic, or probability distribution of words, is valuable information for analyzing framing because we can identify essential objects and their context.

The specifics of our STM and additional data preprocessing are as follows. We assumed that the publication time of an article and the newspaper category of an article based on political perspectives could affect the proportion of the topics estimated by STM in the documents. The unit of a day measures the publication time of items, and one of the three values of the newspaper category is assigned to each newspaper. The names of the newspapers and the newspaper category of each are shown in **Table 1**. If topics from STM provide information on framing, changes in the proportion of topics according to other variables provide clues on changes in framing, depending on the variable.

In our STM, we used only the words that appeared in five or more articles. Terms used in only a small number of items do not provide suitable information for estimating topics. Finally, 45,905 different words were used in our model. Note that the term "코로"(in English "coro"), which BigKinds incorrectly extracted from sentences, was corrected as "코로나" (in English "corona").

We also used Walktrap, a network community detection algorithm for categorizing topics into cohesive subgroups (13, 14). STM also provides information on the correlation among estimated topics. A positive correlation between two topics indicates that the two topics tend to appear in the same document. We assumed that a positive correlation between two topics represented a link between the two topics. Based on this assumption, we built a network among the estimated topics and applied Walktrap to detect relatively cohesive communities of topics. Finding cohesive communities of topics allowed us to infer larger subjects embracing individual topics, which are also valuable information for analyzing framing. Communities of topics present not only specific important objects but also common features of important objects at a more abstract level.

There are many types of network community detection algorithms. We chose Walktrap because it is resilient to the "resolution problem," which refers to the incapability of detecting a community consisting of a small number of nodes, and its strong performance in several experiments (13, 15). We set the Walktrap step parameter to 2, meaning that it calculated the distance between nodes based on a two-step random walk.

All the analyses explained above were performed using R (16) and its packages, including the following: "tidyverse" (17) (for data wrangling and visualization), "tidytext" (18) (for data wrangling), "tidyr" (19) (for data wrangling), "stm" (5) (for STM), "igraph" (20) (for network analysis), "widyr" (21) (for data wrangling), "lubridate" (22) (for handling date), "ggrepel" (23) (for visualization), and "ggraph" (24) (for visualization).

RESULTS

We estimated 80 topics from 37,184 newspaper articles. As previously explained, a topic is a probability distribution of words

(in this case, 45,905 words) and does not have an intuitive meaning. Topics need to be interpreted by human researchers. We interpreted each topic based on three types of information: 20 words with the highest probability in each topic, 20 words with the highest frequency-exclusivity (FREX) score, and 10 documents' titles that contained the highest proportion of each topic. The high probability words indicate the essential objects in the topic. The FREX score supplements the probability. Suppose a word has a high probability for all topics. The word paradoxically does not contain useful information about individual topics. The FREX score is an indicator to overcome this by considering the exclusivity and frequency together (6); that is, a high FREX score word for a topic is important, especially within the topic. Documents with a high proportion of a topic present the realization of the topic in language materials. Two authors considered the three types of information and labeled 80 topics based on an agreement. The results are shown in **Table 2**. The first column contains topic numbers (a nominal value for distinction), and the second column contains labels assigned by the authors. The third column contains numbers assigned to cohesive communities of topics detected by Walktrap. This number is also a nominal value for the distinction between communities of topics. As explained in the Methods section, the communities of topics are used to identify larger subjects or themes from related topics.

Though extracting 80 topics from 37,184 documents produces an excellent summary, the 80 topics represent, nevertheless, a lot of information for humans to grasp intuitively. As previously mentioned, we formed a network of the topics and identified whether there were cohesive communities among them. **Figure 1** presents a visualization of the network. Each node represents a topic, and nodes of the same color belong to the same community. Refer to the second and third columns of **Table 1** for topics belonging to each topic community. As previously mentioned, each topic community is numbered, and this is the third column of **Table 2**. In **Table 2**, 80 topics are arranged by the topic community number. We interpreted topic communities

TABLE 3 | Topic communities' interpretation.

Community #	Interpretation
1	Impact of COVID-19 on everyday life and response of government and citizens
2	Impact of COVID-19 on economy and markets and response of businesses and government
3	COVID-19 situation in other countries and international relations
4	News of schools and other educational institutions and their COVID-19 response
5	Sports news
6	News of confirmed patients, medical staff, and major infection clusters
7	News on the legislative election
8	Falling real estate and apartment prices

in consideration of topics belonging to each topic community. In other words, a more abstract subject to describe each topic community was derived in consideration of its topics. The result is **Table 3**.

STM allows us to estimate the proportion of each topic in the entire document. By adding the proportions of topics in the same topic community, the proportion of each topic community can also be estimated. **Figure 2** shows the results.
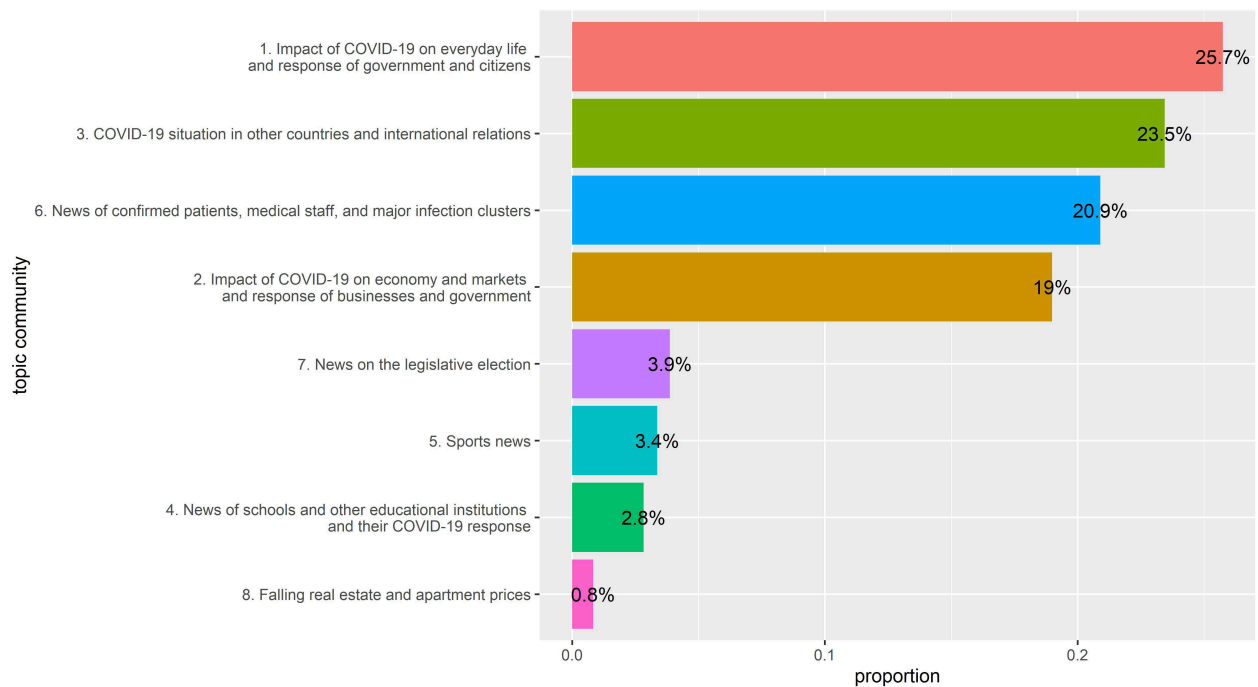
FIGURE 2 | Proportion of topic communities.
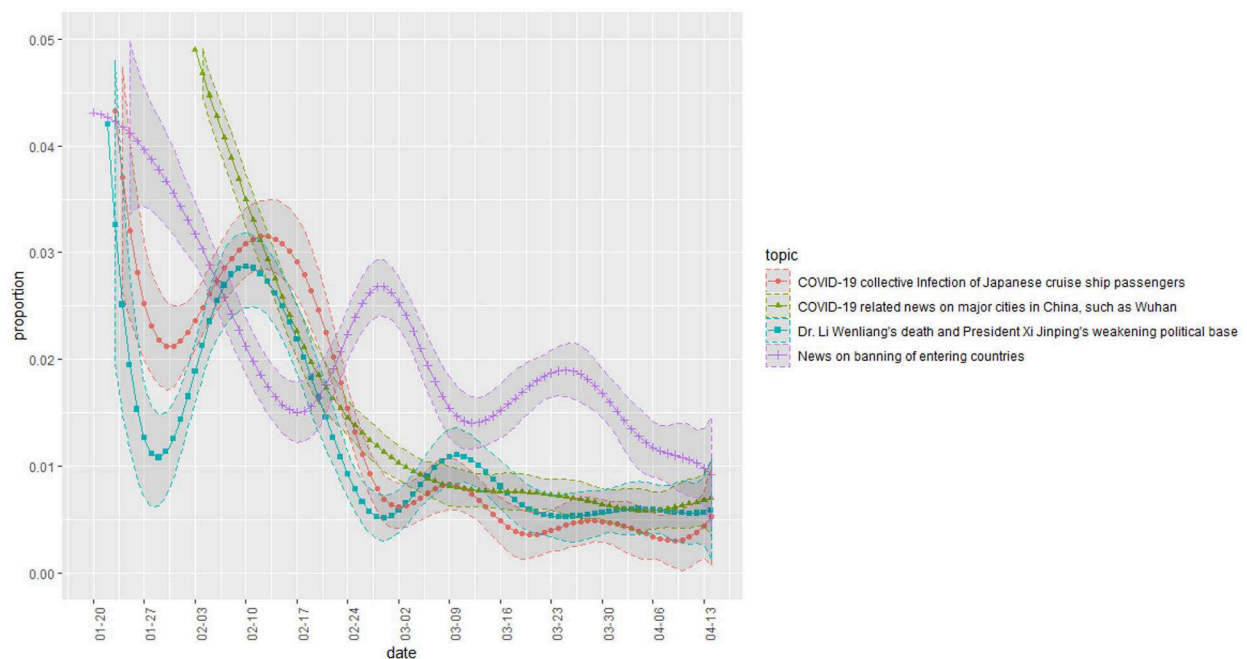
FIGURE 3 | Topic proportion change (1).

While it was predictable that topic community No. 1 dealing with everyday life and No. 6 delivering medical information would be high, the fact that No. 3 had the second highest proportion is a notable result. This result reflects the fact that

COVID-19 is a global crisis. We looked at the change in the proportion of topics in the third community, depending on time and newspaper type. We selected topics 4, 7, 21, 49, 51, 54, 64, and 73, which are significantly related to news of
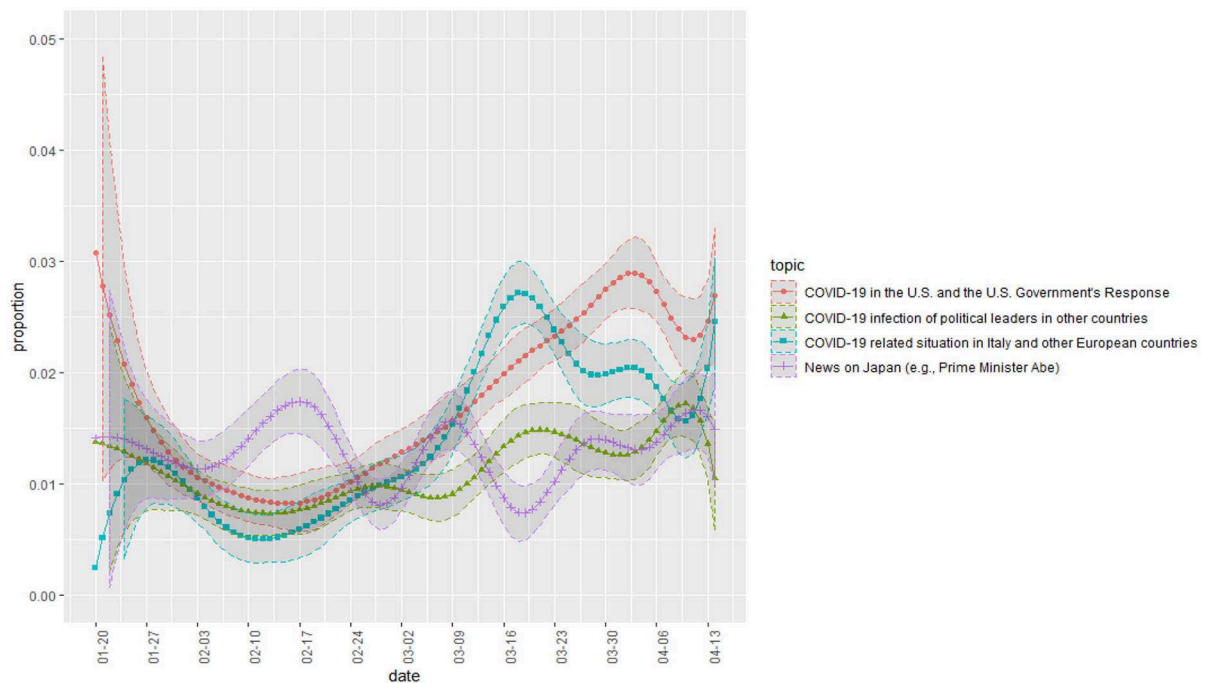
FIGURE 4 | Topic proportion change (2).
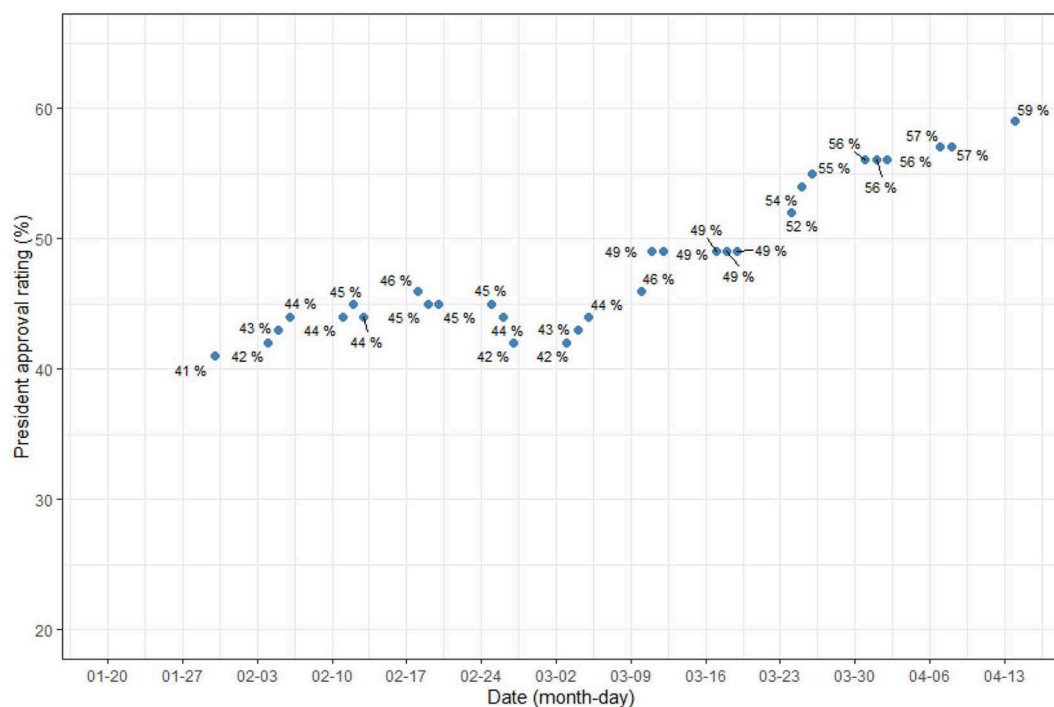
FIGURE 5 | President's approval rating.

other countries, from topic community no. 3 to estimate their proportion changes. Furthermore, we visualized the change in President Moon Jae In's approval rating over the same period to see if the proportion trends of these topics were similar to that of the president's approval rating. Approval rating data is derived from the Gallop Korea Report (25–30).

Figure 3 is a plot of the change in proportion over time in topics whose proportion decreased over time. The topics related to China, entry bans, and Japanese cruise ships. **Figure 4** shows some topics that increase slightly or maintain a steady proportion. They are topics on foreign countries (relative to Korea) other than China. **Figure 5** shows a change in the presidential approval rating, representing an increase over the same period. The topic proportion change in **Figure 4** and the change in presidential approval rating are more similar. **Table 4**

shows the correlation coefficients between the presidential approval rating and the topic proportion in **Figure 4**.

These correlation coefficients have limitations. Since the approval rating of the president was not measured every day, the approval rating over 31 days and the proportion of topics corresponding to those days were utilized: from January 20 to April 14, a total of 86 days, there are only 31 data points. However, the results show that the three international comparative topics (No. 21, 49, 54) have significant positive correlations with the approval rating.

Additionally, we estimated how the above eight topics differed in proportion, depending on the type of newspaper. Specifically, we looked at the difference in proportion between liberal and conservative newspapers. The results are shown in **Figure 6**.

Topics concerning China, the United States, and the ban on entering countries are more prevalent in conservative newspapers than in liberal newspapers.

DISCUSSION

The South Korean government experienced a dramatic rise in its approval rating during the COVID-19 crisis. According to Gallop Korea, the percentage of those who stated, in the performance assessment, that the president was "doing well" rose to 59% during the April 13–14 period, just before the legislative election, from 46% during the January 14–16 period, just before the first confirmed case of COVID-19 occurred. A total of 54% of respondents who gave positive reviews April 13–14 cited the government's strategy in coping with COVID-19 as the reason. Based on this increased approval rating, the ruling party achieved an overwhelming victory in the legislative election, which was unprecedented in South Korea's political history. It won 180 out of a total of 300 seats.

TABLE 4 | Pearson correlation coefficients between topics in **Figure 4** and approval rating.

	Pearson correlation coefficient	p
Approval rating and Topic 21 (COVID-19 in the United States and the U.S. Government's response)	0.9161648	4.868e−13
Approval rating and Topic 49 (COVID-19-related situations in Italy and other European countries)	0.71208	7.035e−06
Approval rating and Topic 54 (COVID-19 infection of political leaders in other countries)	0.7439068	1.617e−06
Approval rating and Topic 73 (news on Japan)	0.1738349	0.3497

FIGURE 6 | Proportion differences among topics concerning international news.

With 10,506 confirmed cases and 222 deaths by April 14, how could the South Korean government and the ruling party have been able to win such generous support? We think that news about other countries and the international comparative framing that resulted can at least partly explain this. In our view, there were two crucial framings related to news of other countries and their changes.

The first was the attempt and decline of the Chinese entry ban framing. By the time South Korea had started to experience COVID-19, China was in the middle of a disease epidemic. During this period, media focused on news of China's infections and the need to ban Chinese entry into South Korea. The high proportion of topics related to Chinese news and entry issues in the early stage (**Figure 3**) shows an active attempt to establish such a framing. Given that such topics had a higher proportion in conservative media (**Figure 5**), it is likely that it was mainly conservative newspapers that attempted this. However, as shown in **Figure 3**, this framing was not well received by the public and gradually declined in proportion.

Instead, the emerging framing emphasized the excellence of Korea's quarantine performance based on international comparisons. As **Figure 4** shows, as COVID-19 spread worldwide, news of infections in the United States and European countries started to take on greater proportions in reports. The infection status in these countries was much worse than in Korea. As these topics expanded their weight, we believe that the conditions formed for a change in domestic public opinion in favor of the current administration. In other words, as international comparisons became more active, Korea's performance was confirmed to be relatively superior, which had a positive impact on the government's approval rating. We speculate that this is the reason the change in the proportion of topics in **Figure 4** and the change in the presidential approval rating of **Figure 5** seem similar.

In sum, we propose that the following occurred. When COVID-19 broke out in South Korea, the legislative election was expected in less than three months' time. The conservative newspapers, well known for their very critical stance toward the current liberal government, seemed to want to use the pandemic to make the ruling party lose. They repeatedly reported negative news. The major logic of their criticism was that South Korea did not ban Chinese entry because the current liberal government was shamelessly subservient to China due to its pro-North Korea policies. Some conservative media even argued that the South Korean government was even more incompetent than the North Korean government because the latter banned Chinese entry very early as COVID-19 broke out. This frame-setting left a strong impression in voters' minds that the government's performance in fighting COVID-19 was the most important criterion when casting their votes. Then, there was a turnaround. While South Korea succeeded in flattening the curve, regions that were considered to be more advanced such as the United States, Japan, and Western Europe began to suffer. South Korea became a model of best practices in the world, in terms of quarantine. The impression that government performance was the most important criterion for casting votes in the legislative election still existed. Voters cast their votes according to this formula, and the landslide victory of the ruling party followed.

A public health crisis is an event in which people see the government's capacity clearly, so it has numerous triggers that can change people's attitudes toward the government. Support for the government has a tremendous impact on the resolution of such a situation. The results of this study show that consideration of framing is necessary to accurately predict changes in government support during these crises.

This study also contributes to the development of methods for measuring media framing. Measuring framing is difficult because data are vast, and a small number of researchers cannot review it all. This study presents the possibility of analyzing framing through computer and human collaboration. While the topics derived from topic modeling methods are not the equivalent of framing, they can provide adequate information regarding framing. Researchers can measure framing efficiently and accurately by making good use of such methods. During an outbreak of a population-wide infectious disease, the news framing government policy can greatly influence disease trends by affecting public opinion. However, measuring framing quickly and properly responding to it is difficult. Our approach using topic modeling will contribute to the formulation of efficient public health policies considering media framing.

The main limitation of this research is that our analysis was limited to traditional media: the major newspapers. As is well-known, a variety of new media such as YouTube and various social media have recently emerged. Future analyses should also cover the framing of these media. Another limitation is that a more sophisticated time-series analysis could not be attempted. This study analyzed only the simple correlation between the approval rating and the topics' proportion because of the limitations of the data. It is necessary to obtain more data in the future and attempt sophisticated time-series analyses such as cross-correlation analysis.

DATA AVAILABILITY STATEMENT

Publicly available datasets were analyzed in this study. This data can be found here: https://www.bigkinds.or.kr.

AUTHOR CONTRIBUTIONS

WJ: data analysis, result interpretation, and writing manuscript. DC: research direction setting, result interpretation, and writing manuscript.

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COVID-19: The World Community Expects the World Health Organization to Play a Stronger Leadership and Coordination Role in Pandemics Control

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The coronavirus disease 2019 (COVID-19) pandemic has been accompanied by the return of the concept of national state and exhibited signs of crisis of globalism and liberalism. The pandemic affected most aspects of society and human activity, including socioeconomic impact. Economic problems, shortages of medical supplies and personnel, xenophobic sentiments, and misinformation led to the use of unethical practices and human rights violations. To navigate through this crisis, many countries resorted to traditional diplomacy in the absence of effective international instruments. Thus, the world faced the urgent need in functioning global governance. The pandemic also manifested the increasing importance of international organizations as sources of technical expertise, providing scientific basis for politicians to legitimize their decisions and actions. The article addresses the topic of implications of the pandemic for governance and forecasting a post-pandemic future. The research focus of this paper, therefore, is the assessment of the role of the World Health Organization (WHO) in prevention and response to pandemics. The work is aimed at identifying the functions of the WHO and assessing its activities in prevention and control of pandemics and response to the COVID-19 pandemic in particular. Furthermore, the objective of this article is to identify gaps in the WHO pandemic control efforts and formulate recommendations on addressing them.

Keywords: World Health Organization, COVID-19, international health regulations, pandemics, pandemic response, pandemic prevention

INTRODUCTION

The coronavirus disease 2019 (COVID-19) pandemic and other recent and ongoing infectious disease outbreaks, emerging, re-emerging, and neglected infectious diseases, as well as bioterrorism, posing a threat to health security, suggest the necessity and significance of pandemics-related research. The control of pandemics is impossible without international cooperation, due to their transboundary nature, and intergovernmental organizations are to play an important role in pandemic preparedness and response. The World Health Organization (WHO) is the only source of legally binding international regulations for pandemic response, the importance of which is growing, and a provider of technical assistance and standard guidelines to the states (1). Strong

national health systems are the foundation for effective pandemics prevention and control, and their strengthening is crucial, especially in low-income countries. The international system of mechanisms of response to pandemics is currently in the process of formation, and it is a dynamic process. The challenge for such system is to ensure the existence of supranational legal authority and make it function. The authority and the capacity of the WHO to lead the international response have been questioned during the Ebola outbreak and the COVID-19 pandemic. The crises also revealed the lack of resources of the WHO to effectively prevent and respond to pandemics (2). At the same time, the role of emerging influential and resourceful actors in pandemic control has been growing, including the World Bank Group, the Bill and Melinda Gates Foundation, Médecins Sans Frontières, and other organizations. One of the central issues in international efforts to prevent and control pandemics is the aid to the poorest countries to develop health systems and ensure availability and accessibility to the basic health services by their population (3).

THE ROLE OF THE WHO IN PANDEMIC PREVENTION AND CONTROL

The role of international mechanisms advanced significantly from adopting the WHO International Health Regulations (IHR) in 1969, focusing on just three diseases (cholera, plague, and yellow fever), to approving the current version of the IHR in 2005 and to creating the WHO Contingency Fund for Emergencies (CFE) in 2015 (4, 5).

During the SARS outbreak in 2003, the problem of coordinating response actions in different countries already became obvious. The existing response mechanisms were rather slow and disorganized. The outbreak revealed the necessity to modify the IHR. The revision of the IHR in 2005 allowed the WHO to declare Public Health Emergency of International Concern (PHEIC) and required the Member States to strengthen national emergency response capacity. The revised version of the IHR was tested by H1N1 influenza outbreak in 2009, when weaknesses in the global response to influenza pandemic were revealed again. The WHO issued recommendations to the Member States to create more extensive reserve global health workforce and establish $100 million contingency fund for future pandemics. However, these recommendations were not implemented until 2014 (6). The Ebola crisis revealed the importance of legal instruments and raised legal and ethical issues, due to, for example, introduction by some governments of trade and travel restrictions. This outbreak questioned the WHO credibility and the effectiveness of the IHR (7).

The WHO plays a key role among all intergovernmental organizations involved in tackling pandemics, and it is the only source of legal authority. The core functions of the WHO related to pandemics prevention and control include the following: support Member States in developing national capacity to respond to pandemics, support training programs, coordinate Member States for pandemic and seasonal influenza

preparedness and response, develop guidelines, and strengthen biosafety and biosecurity (8).

The main instruments used by the WHO for pandemic prevention and control include the IHR, the Global Outbreak Alert and Response Network (GOARN), the Public Health Emergency Operations Centre Network (EOC-NET), the Contingency Fund for Emergencies, and the Pandemic Influenza Preparedness (PIP) Framework. At the strategic level in pandemic control, the WHO focuses on reinforcing national public health systems, One Health approach, and strengthening global partnership.

The IHR is a legally binding regime for protection and management of disease threats. It is a framework for collective response to the threats, involving one or more countries, or to public health events of global significance. The current version of the IHR entered into force on 15 June 2007, and they are binding on 196 countries across the globe, including all WHO Member States (1).

To date, the progress has been achieved in some areas of the IHR implementation, for example, introduction of national focal points to connect with different government sectors, stakeholders, and the WHO; increased transparency in reporting; improved use of early warning systems; and enhanced cooperation between organizations dealing with human and animal health. Nevertheless, there are still significant gaps related to the IHR. By the original deadline of June 2012, only one-fifth of the 192 WHO Member States had met the core capacity requirements, and by 2019, one-third (9). The problems related to the IHR implementation are lack of resources and difficulties in developing effective public health services. The IHR are not flexible enough to be adapted to local conditions. The criteria and mechanisms for declaring public health emergencies and for complying with the IHR need to be improved. The procedures should be simplified for the countries with scarce resources (3, 10).

In order to provide rapid access to resources and expertise for effective response to public health emergencies, in 2000, the WHO and partners established GOARN. The network provides a global operational framework encompassing a wide range of capacities and expertise, and it is aimed at coordinating support to countries and effectively deploying response teams. GOARN links over 200 institutions and networks and includes over 600 partners around the world (11). Since its establishing, the network has been involved in 135 field missions in 90 countries, deploying over 2900 professionals to the field (12). GOARN is considered to be effective, and it has gained trust and respect. The WHO stresses the importance of training and maintaining a reserve global health emergency personnel (13). GOARN focuses on the technical support roles and improving surveillance. Despite its efficiency, during Ebola outbreak, it became clear that GOARN needs to strengthen its leadership, respond faster, and broaden its capacity (6).

In 2012, the WHO established EOC-NET to identify and disseminate best practices and standards for EOCs and support EOCs' capacity building in Member States. The WHO works with EOC-NET partners to develop evidence-based guidance for establishing, operating, and improving EOCs (14).

Considering the criticism of the WHO in terms of lack of resources and slow response to emergency situations, CFE was established by the World Health Assembly in 2015, with the target funding of US$100 million for the 2018/2019 biennium. This target has been achieved. Since the establishment of CFE, the Member States have contributed over US$130 million to it (15). The distinctive feature of this fund is that it can be mobilized within 24 h, while the other financing mechanisms have different funding criteria and slower disbursement cycles. For this fund to be effective, it needs to attract greater levels of multi-year flexible financing (16).

PIP Framework for the sharing of influenza viruses and access to vaccines and other benefits is an international agreement adopted by the World Health Assembly in 2011 to improve global pandemic influenza preparedness and response. The Framework includes a PIP Benefit Sharing System that foresees an annual Partnership Contribution to the WHO from influenza vaccine, diagnostic, and pharmaceutical manufacturers through the WHO global Influenza Surveillance and Response System (17). Through this mechanism, the WHO will ensure the immediate availability of necessary products in case of influenza pandemic. Furthermore, WHO partners have contributed US$198 million to improve pandemic influenza preparedness and response. According to Gostin et al. (18), even though PIP Framework is not a treaty, it has features of international law, such as collective accountabilities, partners collaboration, and compliance procedures.

Global partnership is one of the main areas of work to guide the IHR implementation. Key partners to support the WHO implementation include the Food and Agriculture Organization, the World Organization for Animal Health, the UN Children's Fund, the International Labour Organization, the European Union (EU), international aid agencies, WHO collaborating centers, and non-governmental organizations and foundations (19).

RESPONSE OF THE WHO TO THE COVID-19 PANDEMIC

According to the provisions of the IHR, on 30 January 2020, the WHO declared the outbreak a PHEIC and assessed the risk as very high for China, and high at the global level. On 11 March, the WHO said that the outbreak can be characterized as a pandemic (20). The WHO did not recommend limiting trade and movement, in line with IHRs. Many countries, however, have not followed these recommendations (21).

Shortly after announcing the pandemic, the WHO launched the COVID-19 Solidarity Response Fund. This initiative allows individuals and organizations around the world to directly support the work of WHO and partners to help countries with greatest needs prevent, detect, and respond to the COVID-19 pandemic. The disbursement mechanism for money raised through the Fund is quick and flexible. As of July 2020, the Solidarity Response Fund collected more than 200 million USD from more than 500,000 individuals and organizations (22). Furthermore, the WHO has also been involved in other

fundraising efforts, such as establishing the WHO foundation and organizing charity concerts.

Another key initiative to respond to drastic medical supply shortages and potential food crisis in a number of countries, the WHO in collaboration with the World Food Program established the UN COVID-19 Supply Task Force in April 2020, within the framework of COVID-19 Supply Chain System. This mechanism has been created to coordinate the procurement of medical supplies to countries with overwhelmed health systems. This initiative will be run by the WHO and the World Food Program, together with a number of UN partners. The supply chain hubs will be located in Belgium, China, Ethiopia, Ghana, Malaysia, Panama, South Africa, and the United Arab Emirates. According to the WHO, the supply chain may need to cover more than 30% of the world's needs in the acute phase of the pandemic (23, 24). Prior to launching this mechanism, the WHO has already shipped personal protective equipment and diagnostic tests to over 120 countries.

The WHO has also launched a "Solidarity Trial" initiative, an international clinical trial, with the participation of 90 countries, aimed at finding effective treatment through rapidly discovering whether any existing drugs can slow the progression of the disease, or improve survival (25).

In collaboration with partners, the WHO launched a Global Collaboration to Accelerate the Development, Production, and Equitable Access to New COVID-19 diagnostics, therapeutics, and vaccines (26). The WHO has been extensively involved in providing training and technical assistance thought its OpenWHO platform and GOARN knowledge hub and in deploying experts via GOARN network (27). The WHO tackles misinformation through carrying out various online campaigns and being active on all social media channels. It releases daily situation reports and holds press conferences for updating the media about the pandemic. In March 2020, the WHO has started allocating the funds from CFE by releasing $9 million to the most vulnerable countries (28).

The response initiatives by the WHO have come under criticism, mainly by the US President Donald Trump, who accused the WHO for failure to control the pandemic and for promoting the interests of China. In April 2020, D. Trump announced the suspension of the US financing of the WHO and later on the withdrawal of the US membership in the WHO. However, other members such as China, France, and Germany pledged extra funding to the WHO to compensate for the lack of resources (29, 30). Thus, the WHO has been engaged in political confrontation, which has led to changes in balance and redistribution of influence among the Member States.

DISCUSSION

COVID-19 and previous pandemics have tested the leadership of the WHO and revealed a number of problems in its activities. The WHO response to both the 2009 influenza pandemic and the COVID-19 pandemic has been extensively criticized. The main points related to the WHO pandemic prevention and control activities that have come under criticism are as follows:

1. Over/underestimation of threat.
2. Conflict of interest and political bias.
3. Problems related to the IHR implementation.
4. Slow response.
5. Lack of financial resources.
6. The WHO is seen as a more political and less technical organization (6).
7. The WHO pandemic preparedness plans are ill-equipped to foresee and solve unique ethical challenges that may arise during different infectious disease outbreaks (31).

Apparently, the allegations of overestimation of threat and accusations of conflict of interest following the 2009 influenza pandemic have led the WHO to be more cautious in its statements and in declaring PHEIC and pandemic. The WHO followed experts' advice to mobilize the wider national, regional, and international community at earlier stages of an outbreak prior to a declaration of a PHEIC (3).

The majority of countries do not meet the core capacity requirements for the implementation of the IHR (9). A number of provisions the IHR have been violated by countries during the COVID-19 pandemic, as it had already happened during the Ebola pandemic (32). There is no multilateral strategy or funding to address the problem of pandemic preparedness and developing capacities for implementation of the IHR in low-income countries (7). At the same time, progress has been achieved in such areas as surveillance and communication among stakeholders involved in pandemics control and organizations dealing with human and animal health.

Some experts argue that the IHR do not create international law that is binding on the participant countries, due to the implementation and compliance problems. In practice, the international community applies "soft law" that implies non-binding duty to collaborate with other countries and with the WHO with regard to infectious disease surveillance and control of outbreaks. Although such "soft law" is neither mandatory nor enforceable, it is powerful politically. The reasons for why this "law" is functioning are that contributing to and enhancing international collaboration in infectious disease response is in a country's self-interest and that the WHO managed to create a framework for international cooperation on infectious diseases that is able to withstand the increasing global threats posed by pathogens (33). Suthar et al. (34) consider sanctions and embargoes a viable alternative to the functioning IHR. While using such measures can be inevitable in certain situations, as practice shows, these instruments can be based on the principle of double standard and be used for political manipulation purposes.

The WHO has been working on adjusting its policies and activities according to identified gaps, for example, by establishing the CFE. Experts point out evident progress in the WHO response to the Ebola outbreak in Congo in 2018, compared to its response to the 2014 outbreak (32). During the COVID-19 pandemic, the role of the WHO as a source of information and knowledge dissemination organization turned out to be critical, due to uncertain rapidly evolving situation and a lack of data and scientific knowledge about the virus and the disease. Given the significant impact of misinformation on countries' pandemic control efforts, this function of the WHO is especially important in the countries with low trust in government.

The WHO pays special attention to developing collaboration with other organizations involved in pandemics preparedness, focusing on One Health Approach. During the COVID-19 pandemic, the WHO has been collaborating and coordinating response with a wide range of international organizations, including the World Bank Group, various UN agencies, Gavi, the Global Fund, the EU, etc. (35).

The recommendations to improve the WHO capacity to prevent and control pandemics are as follows:

1. Continue the ongoing reform of the WHO.
2. Member States should ensure stable financing for the organization.
3. The WHO should work on increasing its credibility, paying special attention to ensuring the organization's transparency, political and business neutrality, and adapting evidence-based decisions and policies.
4. The member states should develop political trust, and the organization should be unbiased, distance itself from politics, and focus on its technical functions.
5. Focus the international efforts to tackle pandemics on long-term development aid programs and projects.
6. Concentrate efforts on developing basic health infrastructure and strengthen health systems in countries most vulnerable to pandemics.
7. Further consider the options for the IHR enforcement mechanism and the IHR revision.
8. Create a coordinated, adequately funded global health initiative to deliver assistance to the vulnerable countries to build their capacities to implement the IHR.
9. The WHO should further collaborate with partners to resolve the issues, indirectly related to the WHO functions, that impede effective prevention and control of pandemics.

The most vulnerable countries to pandemics are conflict-affected countries (36). Therefore, a powerful instrument to prevent pandemics is the prevention of conflict escalation. The aid efforts, including the efforts to strengthen health systems, will be ineffective and inefficient as long as the governments are involved in conflicts in the pursuit of taking over natural resources and boosting the profits of military corporations. Furthermore, the countries–beneficiaries of development aid can critically perceive the contradiction between the negative effects of economic policies dictated by the donors and development aid initiatives aimed at mitigating various effects of such policies on society and health of the population (37). Such issues, however, do not fall under the direct responsibility of the WHO, and the WHO cannot be held accountable for these shortcomings.

In response to the COVID-19 pandemic, the WHO has been working in line with its core functions related to pandemic control. It has used some of the existing mechanisms for pandemic prevention and control and created new ones to respond to COVID-19. Overall, given the situation of uncertainty and lack of knowledge about COVID-19, the WHO has taken

timely appropriate steps in the initial response to the pandemic. The measures adopted by the WHO lie within the scope of the organization and have been limited by its mandate and available resources. Lessons learned from COVID-19 pandemic response should be further analyzed, and the organization's emergency response mechanisms and capacity should be improved, as discussed above. Many experts agree on the necessity to provide the WHO with more resources and stable financing and extend its mandate (2, 3, 38). The world community expects the WHO to play a stronger leadership and coordination role.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

AUTHOR CONTRIBUTIONS

The author confirms being the sole contributor of this work and has approved it for publication.

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frontiers
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Lessons From Italy's and Sweden's Policies in Fighting COVID-19: The Contribution of Biomedical and Social Competences

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We start (section The COVID-19 Pandemic and Italy's Response to It) by focusing on Italy's "tough" response to COVID-19 pandemic, which included total lockdown with very limited possibility of movement for over 60 million individuals. We analyse (section Sweden's Softer Approach) Sweden's softer approach, which is based on relatively lax measures and tends to safeguard fundamental constitutional rights. We problematise (section General Disagreement Among Experts: A Pressing Epistemic Problem) around the stalemate that arises as a consequence of the implementation of these different approaches, both epistemically grounded and equally justified, in the face of an unknown virus, in society. We point out that in some cases, like the one we discuss here, the epistemic justification that underlies scientific expertise is not enough to direct public debates and that politicians shouldn't exclusively focus on it. We claim that, especially in situations of emergency when experts disagree, decision makers ought to promote broad discussions, with attention to public reason as well as to constitutional rights, in the attempt to find a shared procedural and democratic agreement on how to act. On these grounds (section The Need of More Public Discourse in Fighting Covid-19) we call for an increase role of different types of expertise in public debates thus for the inclusion of ethicists, bioethicists, economists, psychologists, moral and legal philosophers in any scientific committee responsible for taking important decisions for public health, especially during situations like pandemics. Likewise, in the interest of public reason and representativeness, we also claim that it may be fruitful to bring in non-experts, or experts whose expertise is not based solely on "epistemic status," but rather on either experience or political advocacy, of either the homeless, the immigrant, or other disenfranchised groups. This, in expanding the epistemic-expert pool, may also make it "more representative of society as a whole."

Keywords: COVID-19, public health, expertise, scientific disagreement, ethics, science

THE COVID-19 PANDEMIC AND ITALY'S RESPONSE TO IT

As of September 2020, SARS-CoV-2 -a coronavirus which likely originated in Wuhan, China- that causes COVID-19 - has been ravaging the world (almost 30 million people infected), causing the deaths of almost 1,000,000 people (at the time of writing)[1].

The virus's etiology is still not-well understood; however, it is known that it propagates quickly among humans by close contact, air currents, by touching contaminated objects or through respiratory droplets produced when an infected patient coughs or sneezes[2]. The virus may cause, in its strongest manifestations, acute respiratory infections that lead to the death of the individual that contracted the virus [estimated mortality rate was 3.4% as of March (1), with significant regional differences[3]].

The ease of contagion of COVID-19 (on March 11th 2020 the World Health Organization described the Covid-19 situation as a pandemic) and the growing number of deaths (with families being decimated) along with the collapse of ICUs has prompted the authorities to adopt measures (such as generalized reduction of transport and economic activities) to prevent the virus from spreading further. These measures have caused dramatic effects (e.g., freezing of international trade, increase in unemployment, crude oil prices below zero) on the world's economy. Such effects are likely to trigger, despite Governments/Institutions' attempt to inject money into suffering economies[4], a global recession.

In this context, biomedical experts (such as virologists, epidemiologists, immunologists, public health scholars, and statisticians) have acquired an increasingly central role in public debates. They acquired such a role by virtue of their epistemic authority (2), which loosely speaking depends on established knowledge combined with an education of excellence, success in one's field, academic achievements, recognition by colleagues, and high positions in leading institutions.

Biomedical experts have been elaborating models of contagion, strategies for preventing the virus from spreading further, and offering precious advice to politicians for implementing public health policies devised to safeguard society. In the face of a new, aggressive virus, for which there was no cure, health systems have shown themselves to be remarkably unprepared. As a consequence, the political authorities have had to rely more and more on the experts to try to formulate health policies suitable to contain the pandemic. The public too, confronted with the imminent serious threat, has not shown any of the recent tendencies of mistrust toward science and scientific reasoning recently observed (3).

Two different types of approaches to dealing with the COVID-19 pandemic have, as a result of this process, emerged. One, that is exemplified by Italy (but also shared by most governments in the world at different degrees) of severity and control, based on state-enforced quarantine. The other, exemplified by Sweden (and partly shared, at the outset at least, by countries like the USA and the UK) of relative relaxation, in which quarantine is not implemented for various reasons (economic, constitutional or alleged scientific ones) and relatively lax measures of prevention are deemed to be sufficient to stop the pandemic[5].

In this section we briefly look at the Italian response to the coronavirus pandemic. Italy's COVID-19 epidemic, which as of July claimed more than 35,000 lives on a population of ∼60 million individuals, exploded in the wealthy and prosperous North, where it put under significant pressure one of Europe's most developed health care systems.

In order to prevent mass contagion throughout the country, which would have caused catastrophic effects in the less prosperous and developed (infrastructurally, at least) South, the Italian government advised by a team of medical experts [known as *comitato tecnico scientifico*] implemented a series of measures, which involved: (i) restriction on movements; (ii) enforced quarantine; (iii) bans on travel and assemblies; (iv) closing of all stores except essential services, (v) shutting down all municipal borders; (vi) uniformed police and armed soldiers setting up checkpoints around the country.

In accord to the stringency index (which records the strictness of "lockdown style" policies that primarily restrict people's behavior) calculated by the Oxford COVID-19 Government Response Tracker[6], at mid-March Italy scored 90.48, the most stringent level alongside with Spain. At that time Sweden scored 28.57 and it was among the countries with the least stringent measures in the world. As of mid of July, Italy scored 58.33 and Sweden 38.89.

The harsh measures implemented by the Italian government (∼2 weeks after the first cases were discovered in the country's North) arguably came in too late and did not manage to prevent the surge of cases that has heavily taxed the capacity of an extremely well-regarded health care system. In particular, it is deemed that policy makers should have stressed the message "don't meet anyone" rather than merely "stay at home," due to the special familiar and relational structure and functioning of Italian society. However, after months of lockdown, the situation in Italy was gradually getting under control and the country—as of July 2020 seemed to have "flattened the curve," meaning that it successfully managed to slow down the spread of the infection[7]. IC units were readily available and less cases were being discovered. On these grounds, the Italian government ordered a gradual reopening of the country, even though the contagion was not zeroed.

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[1]https://coronavirus.jhu.edu/#covid-19-basics (accessed August 2020).

[2]https://www.who.int/health-topics/coronavirus#tab=tab_1 (accessed August 2020).

[3]https://worldmapper.org/maps/coronavirus-cases-mortality/ (accessed August 2020).

[4]https://ec.europa.eu/info/live-work-travel-eu/health/coronavirus-response/economy_en (accessed August 2020).

[5]We are not considering here the response of some countries, like Belarus, whose President adamantly refused to accept the gravity of the pandemic and suggested its citizen to visit saunas and drink more vodka to avoid contagion: https://www.forbes.com/sites/jamesrodgerseurope/2020/04/04/in-belarus-lukashenko-has-his--own-ways-for-the-country-to-face-coronavirus/

[6]https://www.bsg.ox.ac.uk/research/research-projects/coronavirus-government-response-tracker (accessed August 2020).

[7]https://coronavirus.jhu.edu/data/new-cases (accessed August 2020).

SWEDEN'S SOFTER APPROACH

Sweden's COVID-19 pandemic has, as of July 2020, caused the death of almost than 6,000 people on a population of roughly 10 million individuals (Sweden's population is 1/6 of Italy). At the onset of the pandemic, the Swedish government (advised by some of the country's top epidemiologists, such as Prof Anders Tegnell) decided not to enforce lockdown (many businesses, including restaurants and bars stayed open) or to impose strict social-distancing policies (borders and schools for under-16s were also open). It only implemented a minor set of restrictions (such as banning gatherings of more than 50 people) and relatively lax trust-based measures (such as telling older people to avoid social contact or recommending work from home) to protect and safeguard society.

This was done for two reasons mostly. These are scientific/economical and constitutional. Firstly, Sweden's Public Health Agency -based on findings it gathered across the country[8] deemed that closing-down all businesses would be useless to stop the pandemic because COVID-19 had already reached the country. In addition, the biomedical experts consulted by the government (such as Professor Anders Tegnell)[9] remained adamant that enforced quarantine would be undesirable (for psychiatric, psychological, and physical reasons) and even counterproductive (in terms of the economic repercussions it would have on Swedish economy). Secondly, according to Swedish laws on communicable diseases[10], it is the citizen -not the Government- that has the responsibility not to spread the disease. These laws tend to defend acquired constitutional rights (such as freedom of movement and freedom of assembly) and because of them quarantine can only be contemplated for people or small areas (such as a school or a hotel) but cannot be legally enforced on larger geographical expanses of land (e.g., regions).

Sweden's less intuitive and more controversial approach can be praised for attempting to safeguard citizens' freedom[11], which quarantine seems to threaten. However, the potential cost in terms of human lives of this approach has also raised many concerns[12].

Several researchers[13] have criticized the Agency for Public Health and the experts chosen by the government for not having fully acknowledged the role of asymptomatic carriers.[14] Others have criticized the increasingly neoliberal turn of the Swedish government, the dismantling of its health infrastructure and its large business orientation (4). Moreover, it is not clear whether this softer approach to the pandemic can really bring about the economic benefits it promises. Recent data have shown that Swedish's economy won't dodge economic hit despite its light touch to the pandemic[15].

More importantly, despite a relatively recent study (5) suggested that Sweden's limited lockdown measures may have resulted in fewer death than expected, evidence is mounting that the Swedish's approach to curb the COVID-19 pandemic has not been as successful as first thought[16]. Mike Ryan, executive director of WHO's Health Emergencies Program, recently condemned herd immunity as a strategy to deal with the infection: "it can lead to a very brutal arithmetic that does not put people and life and suffering at the center of that equation."[17] Regardless of herd immunity, which clearly has not been achieved (the proportion of Swedes carrying antibodies is still believed to be well below 10%), Swedish death raise has become indeed very problematic. Sweden has a death toll greater than the United States: 564 deaths per million inhabitants compared with 444, as of July 27[18]. Sweden also has a death toll comparable to that of Italy (581)[19] but nearly five times greater than that of the other Nordic countries combined[20], which seems to suggest that under similar (cultural, geographical, infrastructural) conditions the death toll could have been much lower; hence, that many lives could have been saved if a different approach had been pursued.

However, as data may quickly change again, we ought to preach prudence and avoid drawing sharp conclusions. For this reason, given the evidence available at the time of writing, it seems reasonable to suggest that Swedish's approach needs - at minimum- to be redesigned, so as to take into account not just economic parameters but also to protect and defend the lives of Swedish citizens' in the interest of public health. Additionally, even if Sweden's approach would turn out to be better than the competing one (which at the moment seems very unlikely) significant concerns would remain about its possible potential application to other countries, such as Italy. Applying the Swedish approach to Italy (and to many other countries like Italy worldwide), would be quite difficult we believe, and likely result in a massacre for the following reasons. Italy's density is 206 people per Km^2 whereas Swedish density is 1/10 of that, 25 people per Km^2. Swedish population is, as noted above, 1/6

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[9]https://www.nature.com/articles/d41586-020-01098-x (accessed August 2020).

[10]https://www.loc.gov/law/help/health-emergencies/sweden.php (accessed August 2020).

[11]https://sverigesradio.se/sida/artikel.aspx?programid=2054&artikel=7463561 (accessed August 2020).

[12]https://www.theguardian.com/world/2020/mar/30/catastrophe-sweden-coronavirus-stoicism-lockdown-europe (accessed August 2020).

[13]A petition was launched by a group of scientists demanding the government to implement stricter measures. The petition was signed by over 2,000 doctors, including the chairman of the Nobel Foundation, Carl-Henrik Heldin.

[14]"We're not testing enough, we're not tracking, we're not isolating enough. We have let the virus loose," Cecilia Söderberg-Naucler, an epidemiologist at the Karolinska Institute, stated. Joacim Rocklöv, a professor of epidemiology and

public health at Umea University, added, "Does this mean this is a calculated consequence that the government and public health authority think is okay? How many lives are they prepared to sacrifice so as not to … risk greater impact on the economy?": https://www.wsws.org/en/articles/2020/04/03/swed-a03.html

[15]https://www.politico.eu/article/swedens-cant-escape-economic-hit-with-covid-19-light-touch/ (accessed August 2020).

[16]https://forbetterscience.com/2020/04/07/swedish-scientists-call-for-evidence-based-policy-on-covid-19/ (accessed August 2020).

[17]https://eu.usatoday.com/story/opinion/2020/07/21/coronavirus-swedish-herd-immunity-drove-up-death-toll-column/5472100002/ (accessed August 2020).

[18]https://www.coronatracker.com/country/sweden/ (accessed August 2020).

[19]https://www.statista.com/statistics/1104709/coronavirus-deaths-worldwide-per-million-inhabitants/ (accessed August 2020).

[20]https://www.ft.com/content/46733256-5a84-4429-89e0-8cce9d4095e4 (accessed August 2020).

of the population of Italy and the number of single person households amount to ∼2 million, whereas in Italy is ∼8 million (on a population that is 6 times larger though). Moreover, lots of Italian towns are characterized by a rather compact layout with aggregates of houses in the city center (the architecture that make Italian towns so beautiful for tourists). Sweden, on the contrary, has many US style towns with more space between houses and families and also has a larger surface area (450,295 κM² vs. Italy 301,338 κM²). Sweden is characterized by a high level of social and institutional trust, which is significantly lower in Italy. Finally, Swedish are on average more reserved and less outgoing than Italians, who are known to live among relatives in large communities where close contact and deep personal interactions are the social glue.

Having briefly reviewed these two approaches to the current COVID-19 pandemic, we next problematise around the epistemological stalemate that seem to arise as a consequence of their implementation in society.

GENERAL DISAGREEMENT AMONG EXPERTS: A PRESSING EPISTEMIC PROBLEM

The two cases we discussed above are particularly instructive and offer us an opportunity to problematise about the role of science in public debates and specifically around its role in the implementation of public health policies in situations of emergency. Both these approaches are, strictly speaking, scientifically informed and epistemically justified. In brief, this seems to be a case where experts disagree, and their epistemic authority cannot be taken as the benchmark for making complex political decisions that governments should implement afterwards.

As in the case of the outbreak in the UK, scientists disagreed on herd immunity and its effectiveness as a means of controlling the spread of the SARS-CoV-2. But the key point for society was not how effective herd immunity was compared to the lockdown, but how many lives the choice of herd immunity could cost[21].

Now, one can be an advocate of science and appreciate both the immense contribution that science has made in the constitution of our democratic States and in the solution of many daily and existential problems. Our societies certainly cannot do without science in individual lives or in the public square; however, in some cases—like the one we discussed here—the epistemic justification that underlies scientific expertise seems to be problematic and not solid enough to be uniquely used to model public health policies, which have strong normative and axiological implications for many millions of people and may affect how many lives would be spared or lost.

In this sense, both the Italian and the Swedish cases are paradigmatic examples of this problem. In Italy, the lockdown

contributed to save may thousands of lives[22], even if the human cost of the infection has been very high. Biomedical experts insisted on suggesting harsh measures of social distancing, arguing that the primary and imperative goal was to save all possible human lives. Following this approach, however, could come at the price of impoverishing the country to the point that unemployment and company closures would cause direct and indirect harms to the population not much lower than those caused by Covid-19.

In Sweden, instead, the plan agreed between biomedical experts and government was to keep the infection curve as flat as possible without blocking the country. The authorities relied on the Swedes' compliance with the rules for preventing the contagion, without direct impositions and strict sanctions. This "optimized choice" could be defended in terms of cost-benefit analysis, but it remained unclear what could be the impact of this decision in the weaker sections of society (e.g., the elderly).

In the case we present here, the lack of strong epistemic justification, which allowed for different responses to be implemented, was due to a number of reasons, the most important of which were probably (i) the novelty of the virus (previously unknown to humanity); (ii) its relatively mysterious etiology (which implied that none could really be said to be a real expert); and (iii) the fact that experts were still learning about this infection.

This means that, as we write this paper, we are in a sort of paradigm change (6), where hypotheses and theories about novel scientific facts (the COVID-19) are very fluid (hence not mature) and subject to almost immediate falsification. This stage both favors and requires consistent disagreement among experts, who sometimes - *bona fide* - even end up giving ambiguous or contradictory pieces of advice to the population (the most relevant case here being whether people should wear masks)[23].

Part of the problem therefore seems to be epistemic in character, as it lies in the interpretation of what counts as a fact. Experts in different fields have very different beliefs about what facts are, what causes and effects are, what counts as reliable data, and indeed draw on very different sources of evidence to back their views (7).

This, again, can be easily observed in the interpretations that have formed among experts around the ways to best deal with the pandemic. On the one hand, mathematical modelers (8) assumed the virus would behave like influenza. This assumption makes people think that we may allow the virus to circulate under controlled conditions and may suggest decision makers to adopt a lax response (like the Swedish one) that tries to contain the virus spread without, for instance, harming economic activities or citizens' freedom. Other scientists and public health experts (9, 10), on the other hand, have consistently called for mass testing, tracking, and adoption of stringent measures of social isolation, which are rooted in a very different belief; the belief that the virus is not anything like common influenza and

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[21]https://www.bbc.com/news/uk-51865915 (accessed April 2020).
https://www.theguardian.com/commentisfree/2020/mar/18/coronavirus-uk-expert-advice-wrong (accessed April 2020).

[22]https://spiral.imperial.ac.uk/bitstream/10044/1/77731/10/2020-03-30-COVID19-Report-13.pdf (accessed August 2020).
[23]https://www.sciencealert.com/this-is-why-advice-on-whether-you-should-wear-a-mask-is-just-so-confusing (accessed August 2020).

shouldn't be allowed to spread, even under controlled conditions (Italy's response).

Another part of the problem, however, is political in nature and has to do with the way certain political decisions are translated into social policies. This also relates with the topic of who chooses who and what kind of expertise is invited into those committees responsible for taking crucial decisions on public health. In the cases we have analyzed in this paper, it is clear that politics has failed to listen to society as a whole and has not used the critical tool of public reason to critically analyse and refine -when needed- the medical experts' advice.

The approach we propose here thus suggest that one informed viewpoint isn't necessarily enough or better than another informed one, but that a wider range of opinions (provided they are reasonable and sound) ought to be listened to in order for effective decision to be implemented, especially if such decisions involve normative, axiological components and are applied to public health. The idea is not just that certain expert recommendations are based on a poorly established factual basis. This is a common situation, although often overlooked.

The point is that the biomedical experts are called to advise decisions that are political in character and have enormous consequences on people's lives based on their specific scientific expertise. Such scientific expertise, in many cases, does not include public principles, values or public procedures that are instead typical of a pluralist liberal democracy. Experts typically answer technical questions and provide recommendations that are related to their expertise. Decisions with more general consequences should be made by representatives of the whole society according to formalized procedures (11–13) (Pellizzoni[24]).

THE NEED OF MORE PUBLIC DISCOURSE IN FIGHTING COVID-19

This means that one might call, as we do, for a broader and wider conception of expertise as well as for more representativeness, especially when scientific agreement has not crystallized yet and -like in the case we discussed above- biomedical experts alone seem unable to formulate broadly shared, uncontroversial, health policies.

For this reason, in such cases, politicians should not uncritically adopt only medical experts' opinions (which -as shown above- can be diametrically divergent); rather promote and articulate their discussions in the wider society (14), with attention to ethical and moral principles as well as to constitutional rights and to the rights of minorities (15). In brief, in light of public reason (16).

As O'Neill's brilliantly put it: "we have to supply a structure that the members of a wider, potentially diverse and unspecified, plurality can follow, by adopting and following principles of thought and action that an unrestricted audience can follow" (17). Such discussions should therefore promote a shared procedural and democratic agreement on how to act in situations

of emergency (e.g., COVID-19 pandemic) with high trust being put on reliable institutions (to avoid the dangers of relativism) but also on various other forms of expertise (not only epistemic ones).

We surely welcome the recent adoption of ethical principles in many local, regional, national and international committees, especially in medicine [e.g., (18)]. We also acknowledge that, nowadays, non-biomedical experts tend to be included in many bio-medical boards and commissions. For example, bioethicists had very important roles during the Ebola epidemic (19). However, with very few exceptions (20, 21), the current COVID-19 pandemic has highlighted significant underlying epistemic ruptures between medical science, other types of expertise, the general public, and the political response. This is because bio-medical experts, by virtue of their scientific authority, have been often uncritically recognized as more authoritative than other epistemic experts or non-epistemic ones (such as human rights activists, provided that they follow some basic principle of rationality and fact verification). This is perhaps a natural assumption to make in cases like the one we discussed in this paper; however, it may lead— as we have attempted to show- to undesirable consequences and to a stalemate that may threaten the functioning of our societies. It is our opinion that the best strategy to bridge such ruptures and to avoid such problems is to open up science to public discourse and reason and include in any scientific committee responsible for taking crucial decisions on public health ethicists, bioethicists, psychologists, economists, moral and legal philosophers[25]. More importantly we believe that it may be even more fruitful to bring in and give voice to non-experts, or experts whose expertise is not based solely on "epistemic status," but rather on either experience or political advocacy, of either the homeless, the immigrant, or other disenfranchised groups. This process may also contribute to make the epistemic expertise of experts "more representative of society as a whole."

In order words, echoing philosopher and legal scholar Melissa Williams, we argue that "a fair and just public discourse needs at least some direct representation of the voices of those who are minorities or live in dependence because the majority groups (here experts) do not share their particular history and experience" (15).

CONCLUSION

The type of expert's recommendations we have considered here, although technically flawless, are not neutral for individuals and for society and should therefore be evaluated according to procedures that do not merely assess the epistemic authority of their advocates or the adherence of their proposal to scientific criteria. The values at stake are different and often conflicting—the right to health, political freedom, the right to run a business—and the prevalence of one or the other should be entrusted to an assessment typical of decisions

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[24]http://www.leparoleelecose.it/?p=38050 (accessed August 2020).

[25]https://www.theguardian.com/education/2020/apr/29/to-solve-the-problems-of-this-pandemic-we-need-more-than-just-the-science (accessed August 2020).

taken in the public sphere with the participation of various forms of expertise, chosen representatively. And just as we should never give up the contribution of (medical) experts (as in our case), so the state of emergency and the limited time available to make an effective decision, should never prevent an inclusion of normative and axiological elements in the public debate. In other words, we should be drawing on every type of potentially relevant expertise across the humanities, social and natural sciences and on insights from the wider society.

Thus, in our view, the involvement of non-biomedical experts and under-represented categories capable of drawing attention to general values, other principles and procedures should be welcomed as it could help making decisions that are more representative of society as a whole.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

AUTHOR CONTRIBUTIONS

All authors contributed equally to the writing of this paper.

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Effects of Coronavirus Disease (COVID-19) Related Contact Restrictions in Germany, March to May 2020, on the Mobility and Relation to Infection Patterns

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In an effort to contain the spread of COVID-19, Germany has gradually implemented mobility restrictions culminating in a partial lockdown and contact restrictions on 22 March. The easing of the restrictions began 1 month later, on 20 April. Analysis of the consequences of these measures for mobility and infection incidence is of public health interest. A dynamic cohort of about 2,000 individuals in Germany aged 16–89 years provided individual information on demographic variables, and their continuous geolocation via a smartphone app. Using interrupted time series analysis, we investigated mobility by age, sex, and previous mobility habits from 13 January until 17 May 2020, measured as median daily distance traveled before and after restrictions were introduced. Furthermore, we have investigated the association of mobility with the number of new cases and the reproduction number. Median daily distance traveled decreased substantially in total and homogeneously across all subgroups considered. The decrease was strongest in the last week of March followed by a slight increase. Relative reduction of mobility developed parallel with number of new cases and the daily estimated reproduction number in the weeks after contact restrictions were implemented. The increase in mobility from mid-April onwards, however, did not result in increased case numbers but in further decrease. Other behavioral changes, e.g., wearing masks, individual distancing, or general awareness of the COVID-19 hazards may have contributed to the observed further reduction in case numbers and constant reproduction numbers below one until mid-July.

Keywords: COVID-19, case numbers, contact restrictions, Germany, mobile tracking, mobility, interrupted time series analysis, SARIMA model

INTRODUCTION

The outbreak of coronavirus disease (COVID-19) started in China in December 2019 (1) and evolved into a pandemic affecting almost all countries worldwide. Most governments have introduced public health interventions aiming at restricting physical contact and thereby reducing transmission of the virus. The intention is to slow (or even stop) epidemic spread to lower peak health care demand (2). In Europe, Italy was the first country which was severely affected and imposed a lockdown on 22 February 2020 (3). The first COVID-19 case in Germany was reported on 24 January (4). The number of cases per day in Germany exceeded 100 on 5 March.

On 8 March, 1 week before official closure of schools on 16 March, the German Health Minister recommended to cancel events of more than 1,000 attendees. Between 12 and 18 March, all federal states successively enacted the closure of nurseries, schools, and universities. In a televised address to the nation on 16 March, Chancellor Angela Merkel urged all German citizens to reduce the spread of COVID-19 by following the imposed restrictions. In the following weeks, Germany has gradually implemented stricter mobility restrictions, culminating in a "partial lockdown" in several federal states including the introduction of contact restrictions on 22 March (5). The following 2 weeks until 5 April were denoted as lockdown period. On 20 April, the government lifted some of the restrictions. Businesses with a shop floor of up to 800 m^2 as well as car dealers, bicycle, and bookshops were allowed to reopen. Classes leaving school this year are able to resume preparations and final examinations in school (6). Further reduction of restrictions were decided later in April and May 2020, such as opening of restaurants, children playgrounds. and others. We used the time after 26 April as representative period for relaxation. Whereas mobility restrictions were implemented mostly uniformly by federal states, there is substantial variation in the implementation provisions and timing of regulations concerning the reopening. Currently, there are increasing public debates about the appropriateness of these restrictions. Demonstrations against the restrictions increased although the majority of German citizens agree with the governmental rules at large (7). The impact of mobility restrictions critically depends on individual responses. Analyzing changes in mobility can provide insights into the degree to which interventions measures are being followed (8). Behavior changes are likely to vary between subgroups of the population. Using unique mobility data that includes individual characteristics of each person, we aim to describe changes in mobility overall and for specific subgroups of the German population from the time when the restrictions started until mid-May at a time with some shift toward normality.

MATERIALS AND METHODS

Cohort Description

The data used in this study were contributed by members of the German online panel GapFish (9). GapFish is a professionally managed multi-purpose panel for social and consumer research.

Starting from the total GapFish population, a subpanel for mobile tracking research was built by inviting panelists to install a smartphone app which continuously tracks their GPS position. This app ("Footprints App") was provided by the Swiss market research company intervista (10) and was specially designed to continuously collect location data in a battery-friendly way. Since the sole purpose of this app is to collect location data for georeferenced research projects, installing the app has no apparent added value for the end user. Instead, the panelists receive a monthly monetary compensation for their participation in the geotracking. By installing the app, participants declare their explicit consent to being tracked for research purposes. Participation in the tracking can be canceled at any time. All data used in this study were strictly anonymous and, thus, there was no interaction between the research team and the participants. Recruitment of participants was designed to achieve a sample structure similar to the German population with respect to representative quota on age, gender, and region. Deviations from these quota were corrected by including a post-stratification weight for each participant in the analyses. When panelists decided to pause or cancel their participation in the geo tracking they were replaced by new panelists. The panel was supervised such that the number of participants per day was kept approximately constant. During the investigation period from 13 January 2020 to 17 May 2020, a daily average of 2,014 participants contributed location data, resulting in ~200,000 pairs of latitude/longitude WGS84 coordinates per day. We investigated stratification for three age groups (16–29 years, 30–59 years, ≥60 years), gender, and average mobility between 13 January and 8 March (<20 km per day, 20–50 km per day, >50 km per day). In an attempt to extend our analysis to a sub-national level, we furthermore examined the mobility patterns in three different German regions: North Rhine-Westphalia, Bavaria, and the union of the two German city-states Hamburg and Berlin. The regions were selected based on the following considerations: (i) sufficient sample size within the panel and (ii) regional variation. Berlin and Hamburg are the two largest cities in Germany with 3.8 and 1.9 million inhabitants, respectively, and also constitute federal states. Both are also preferred touristic destinations. North-Rhine Westphalia is the most populous federal state with large industrial areas in the west of Germany with some 18 million inhabitants. With more than 70,500 Sq. km, the Free State of Bavaria is the largest of the 16 federal states in Germany and is located in its southeast. With around 13 million inhabitants, it is the second most populous German state. It is also a popular touristic destination. According to[1], since in this analysis only anonymized and grouped data were used which do not allow a re-identification of individuals an ethical statement is not required.

Data Processing

The raw data for this study consisted of 16,730,065 time-stamped latitude/longitude WGS84 coordinate pairs and were stored and processed using the spatial database system PostGIS (11). First,

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[1]Available online at: https://www.med.uni-muenchen.de/ethik/wann_beratungspflichtig.pdf (accessed July 14, 2020).

we grouped the raw data by day and participant ID, resulting in daily individual (but anonymized) time-ordered tracks. We then cleaned the raw individual tracks by removing implausible data points due to signal losses, connection problems, and other sources of technical problems. The cleaning algorithm is based on the detection of sudden spatial jumps in the individual trajectories which cannot be explained by regular motion patterns. The cleaned daily individual tracks were then converted to daily individual traveled distances by simply adding the lengths of the short line segments joining two subsequent locations in the daily track of each participant. Finally, the individual daily traveled distances were aggregated by computing the daily median distance over all participants belonging to a given strata. This aggregation was carried out separately for each of the stratifications of interest.

Interrupted Time Series Analysis

Interrupted time series analysis is a powerful methodological framework to evaluate effectiveness of health policies and interventions (12). The collected data points are split into a reference period to develop a model of the pre-intervention phase and a subsequent period for the evaluation of the changes following the intervention. In this study, the data were split into a reference (training) period from 13 January to 8 March and a post-intervention (evaluation) period from 9 March to 17 May. For the reference period a Box–Jenkins seasonal autoregressive integrated moving average model (SARIMA) was fitted to the logarithms of the median daily distances (13, 14). The SARIMA (p, d, q) × (P, D, Q, S) model is specified by seven parameters. We fixed the seasonality parameter to S = 7 due to the obvious weekly pattern. In order to find the optimal values for the remaining six parameters, we conducted a grid search guided by the Akaike Information Criterion (AIC) and examined the residual distribution and autocorrelation structure of the candidate models. The best-performing model was the SARIMA (1, 0, 0) × (2, 0, 0, 7) model. This model combines an autoregressive process of 1st order with a term modeling the effect of the day of the week. Logarithms were chosen in order to compare relative reductions and to symmetrize the model residuals. The resulting model was used as a forecast of the data to be expected during the evaluation period if no intervention was introduced and to compare these estimates with the observed data. Model training and data evaluation was performed separately for each of the three age groups and repeated for other stratifications. Based on the comparison of predicted and observed data we calculated relative reductions of median distances traveled for each day and each of the strata. For the graphical presentation, the relative reductions for 10 March (Good Friday) and 13 March (Easter Monday) were interpolated because these are public holidays in Germany and thus do not follow the usual weekly pattern. Calculations were done with Python using the module "statsmodels" (15).

Mobility vs. Reproduction Number and Daily Number of Infections

To study the association between mobility reduction and daily numbers of infections we descriptively analyzed the time series of relative mobility reduction, daily number of cases, and governmental estimates of the reproduction number R according to newcast estimation. Data published by the Robert–Koch-Institute was used for the daily number of new infections and estimate of R in Germany[2]. The case series was smoothed using a centered 7-day moving average. The relation of the daily mobility reduction with the reproduction number over time is illustrated graphically.

RESULTS

The analyzed sample consists of a daily average of 2,014 participants in Germany aged 16–89 years. At the beginning of the investigation period (13 January—8 March), we observed an overall median of traveled distances measured through mobile tracking of 15.33 km. The individual distances show large variation with quartiles 3.75 km (25% quantile) and 41.25 km (75% quantile). Those values decreased considerably after mobility restrictions were implemented. Comparing the beginning of the investigation period to the period 23 March to 17 May, the median decreased 46% to 8.22 km. The quartiles decreased to 1.28 km (25% quantile) and 26.6 km (75% quantile).

Visualizing the data in a time-resolved manner, **Figure 1** shows the median distances traveled for each day during the whole study period (13 January 2020 to 17 May 2020) stratified by three age groups (**Figure 1A**), gender (**Figure 1B**), and place of residence (**Figure 1C**). All stratifications in **Figure 1** show consistent weekly patterns for all investigated groups from beginning of the studied period (13 January 2020) until beginning of March. In addition to the dates of important governmental interventions in Germany (indicated with dashed vertical lines), 29 March with a cold spell and Good Friday (10 April) and Easter Sunday (12 April) as public holidays stand out in **Figure 1** as deviations from the otherwise observed weekly patterns. The decline of distances started on the weekend 14–15 March, and is apparent for all investigated groups. While there were substantial spatial differences in mobility (with median daily distances above 20 km in Bavaria and only around 13 km in the city-states Berlin and Hamburg) before the COVID-19 outbreak in Germany, by the end of March median daily distances were almost identical across the federal states depicted in the lower panel of **Figure 1**. All indicated governmental interventions led to a decrease in median daily distances. A slight increase can be observed since the beginning of April and even more clearly with the relaxation of the restrictions on 20 April, but distances are still well below values before the interventions. Mobility rose substantially faster in the large federal states of Bavaria and North Rhine-Westphalia than in the city-states Berlin and Hamburg. At the end of our study period, the initial differences in mobility between states are restored, although at a smaller absolute level. **Table 1** shows in detail the mean distances traveled per subgroup in the three time intervals up to 8 March (reference period), lockdown period (23 March to 5 April), and late relaxation period (26 April to 10 May). Additionally, the analysis of the average reduction rates of the two periods compared to the reference period is shown

FIGURE 1 | Median daily distances traveled between 13 January 2020 and 17 May 2020 stratified by three age groups (**A**), gender (**B**), and state (**C**). Dates of important governmental interventions in Germany are indicated with dashed vertical lines.
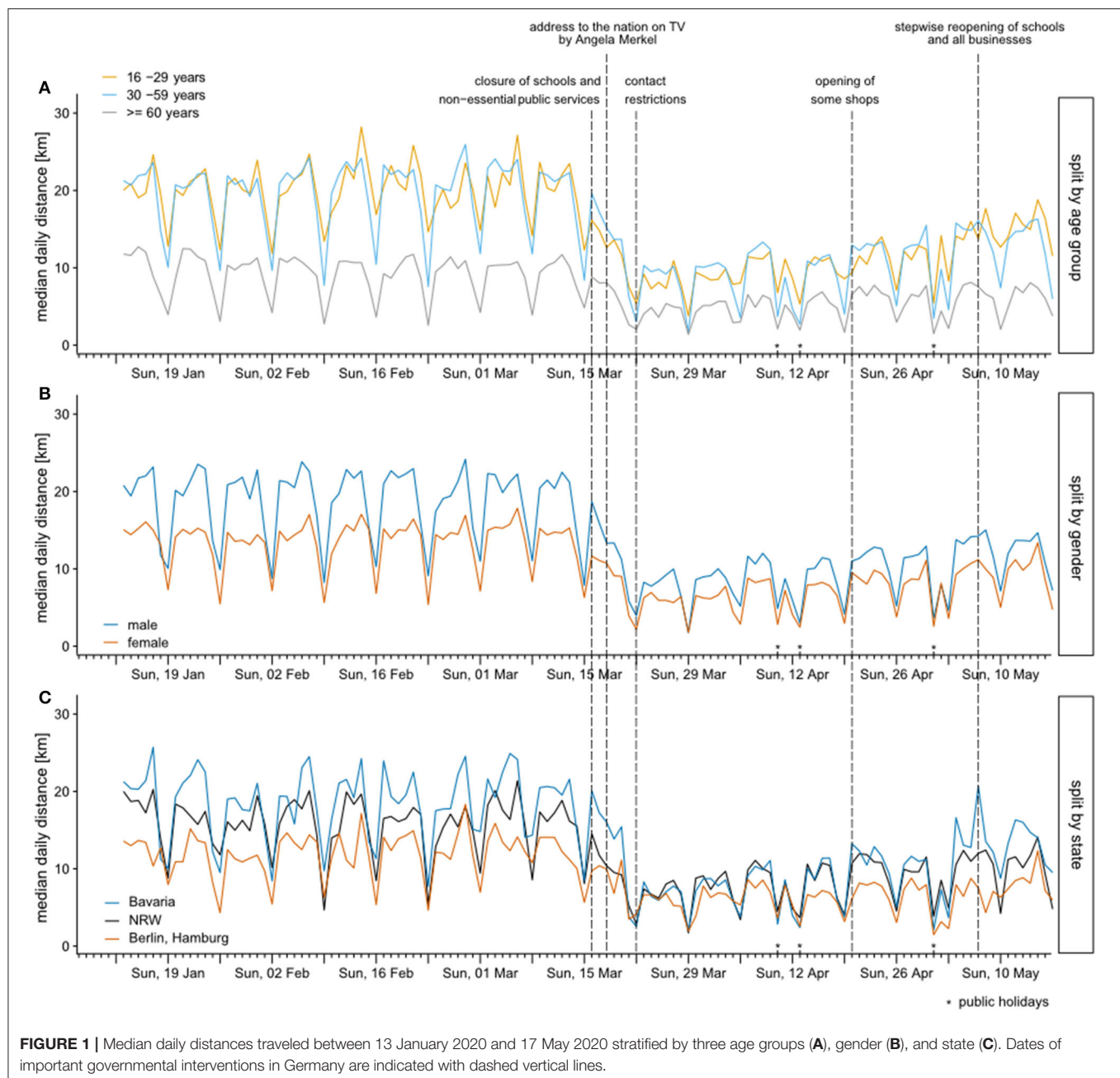
and tested, using an analysis of covariance (ANCOVA) approach. Shown is a formal comparison of the subgroup differences by an interaction test which shows that all subgroup differences were not significant. In the last two columns estimates of the reduction factors in the two periods are reported which were almost identical in the different subgroup samples. The reduction rates were ~60% in the lockdown period and still slightly over 40% in the relaxation period.

To estimate relative reduction of median daily distances, we first used an interrupted time series approach (12). **Figure 2** shows the observed median daily distances traveled by age group for the total period and the projections in the simulation period resulting from the time series

model. When comparing observed median daily distances to simulation results, the median daily distance decreases distinctively for all age groups, with the highest absolute reduction for the younger age groups (**Figure 2A**). Individuals 60 years and older have a smaller absolute reduction, however also a lower median daily distance before the restrictions (**Figure 2C**).

Using the simulated data, we were able to calculate relative reductions of median daily distances traveled. In **Figure 3**, the relative reduction of median daily distance between 9 March and 17 May is displayed stratified by age group, gender, and previous travel habits. The relative reduction is remarkably similar in all age groups until Good Friday (10 April). After that day,

TABLE 1 | Mean values and standard deviations of median daily distances for the reference period and representative periods for lockdown and relaxation within defined subgroups.

Subgroups	Average sample size	Reference period to 08.03.2020 mean (SD)	Lockdown period 23.03.2020– 05.04.2020 mean (SD)	Relaxation period 26.04.2020– 10.05.2020 mean (SD)	*p*-value group-by-period interaction*	Lockdown as multiple of reference (95%-CI) *p*-value	Relaxation as multiple of reference (95%-CI) *p*-value
Gender							
Female	930	13.5 (±3.1)	5.7 (±1.6)	8.3 (±2.7)	0.939	0.41 (0.35, 0.47) <0.001	0.57 (0.50, 0.66) <0.001
Male	1084	18.8 (±4.6)	7.8 (±2.2)	10.9 (±3.7)			
Age groups							
16–29 years	431	20.0 (±3.4)	8.2 (±1.6)	12.7 (±3.0)	0.744	0.43 (0.38, 0.49) <0.001	0.59 (0.53, 0.67) <0.001
30–59 years	1,283	19.6 (±4.6)	8.5 (±2.8)	11.9 (±4.1)			
≥60 years	300	9.2 (±2.7)	4.3 (±1.2)	5.5 (±2.2)			
Region							
Bavaria	280	18.5 (±4.6)	6.8 (±2.0)	11.1 (±4.7)	0.202	0.42 (0.37, 0.48) <0.001	0.53 (0.47, 0.61) <0.001
Berlin/Hamburg	165	11.9 (±2.9)	5.8 (±1.5)	6.2 (±2.4)			
North Rhine-Westphalia	480	15.8 (±3.7)	7.0 (±2.2)	9.4 (±2.9)			

Test of the period-by-subgroup interaction and reported global period effects with corresponding 95%-confidence intervals (CI) are based on the average logarithmized daily median distances.

individuals 60 years and older show a lower relative reduction, with a sharp increase in median daily distances on Easter Sunday (**Figure 3A**). However, this group has still by far the lowest absolute travel distance. No difference between genders can be observed regarding the relative reduction (**Figure 3B**). Interestingly, the relative reduction of median daily distance stayed comparable independent of previous travel habits until 4 April (**Figure 3C**). Afterwards, the relative reduction in the group with <20 km per day before mobility restrictions were implemented was smaller compared to the other groups, again with an outlier on Easter. In the days between 22 March and 4 April, the median relative reduction was as high as 50–75%. In the lockdown period thereafter (between 4 and 24 April), the reduction was smaller, mainly between 20 and 60%. In the period after easing the restrictions the mobility increased, however, remained below the values before the pandemic.

To investigate the potential effect of the achieved mobility reduction on the spread of the virus, we consider the daily relative reduction against the daily reported number of cases and the estimate of the reproduction number for the period from 6 March to 17 May. **Table 2** gives the daily number of cases (point estimate), the estimate of the reproduction number R (7-day value), and the relative mobility reduction smoothed by calculating a centered 7-day moving average[2]. A sharp reduction in mobility was observed in the period March 7 to March 20, followed by a short period of rather constant reduction of about 60% up to ∼April 4, and thereafter a slow increase until the end of the observation period, with the reduction still being about 40%. The development of the daily case numbers, on the other hand, showed a different pattern. A strong increase in daily case numbers was seen from beginning of March for about 2 weeks. The peak period with ∼5,000 cases per day

on average was observed from March 16 to March 21, and after that an almost linear decline followed. The slope was stronger for 1 month until about April 21 with an average daily reduction of case numbers of 100. After that date, the decline gradually became smaller, resulting in daily numbers of about 500 cases per day toward the end of the observation period. The reproduction number was high (above 2) in the first half of March and decreased strongly to values below one thereafter, reaching a relatively constant value which varied between 0.76 and 0.92 after 23 March. This is further highlighted in **Figure 4**, which plots the relative reduction of mobility against R for each day of our study period. After a short period with increasing R and decrease of mobility from March 6 to 10, we observe a parallel decrease from 10 March until 28 March. After that date, as highlighted by color for the months April and May, the mobility increased but R remained on a relatively constant level. We conclude that the reduction on mobility, possibly in combination with other measures had a positive effect to reduce viral transmission. The increase in mobility thereafter was not followed by an increase of R which may be caused by other measures, such as general awareness, wearing masks, and others.

DISCUSSION

In this study, we showed a rapid decline in mobility in the middle of March after mobility restrictions were implemented, while by beginning of April, mobility increased again slightly. Reduction rates were considerable (**Table 1**). Mobility was more than halved in the lockdown period which demonstrates that lockdown politics of the government was respected by the population that obviously relinquished accustomed

FIGURE 2 | Observed median daily distances traveled (colored) by age group for the total period and simulated time series during the simulation period (black). Considered age groups were 16-29 years **(A)**, 30-59 years **(B)**, and 60 years and older **(C)**.
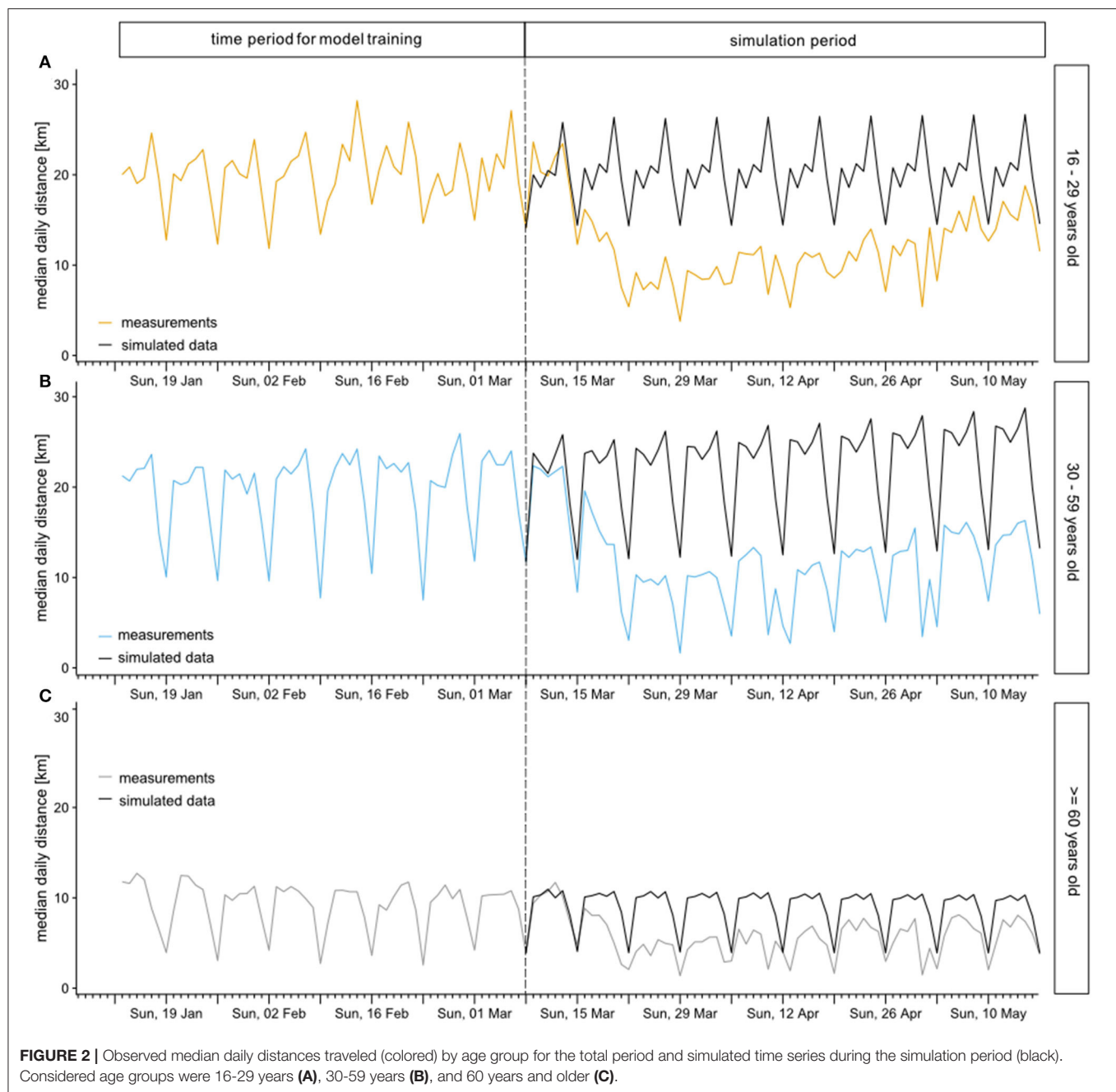
way of living. Even after relaxation of the strict lockdown measures from the end of April onwards, the mobility of the German population did not immediately go back to the pre-intervention level. The mobility reduction rate during the relaxation period (26 April—10 May) still reached about two-thirds of the reduction rate during lockdown (23 March—5 April). This demonstrates the continuation of the careful behavior of people even though political pressure was noticeably retracted. The relative reductions were found to differ little between age groups, gender, and groups with different mobility before the pandemic (**Table 1**, **Figure 3**). Also, the mobility

reduction following the lockdown measures were found to be highly significant ($p < 0.001$) through all stratifications considered (age, gender, and region). On the other hand, no evidence for statistically significant period-by-subgroup interactions was found (large p-values), suggesting that the German population reduced its mobility in a rather consistent and uniform way.

We also examined the development of the reproduction number R which showed a parallel decline after March 10, a few days after the decline in mobility started, until the end of March. Afterwards, the mobility

FIGURE 3 | Relative reduction of median daily distances between 9 March and 17 May, stratified by age group **(A)**, gender **(B)**, and previous mobility defined by distances traveled between 13 January and 8 March **(C)**. Dates of important governmental interventions in Germany are indicated with dashed vertical lines.
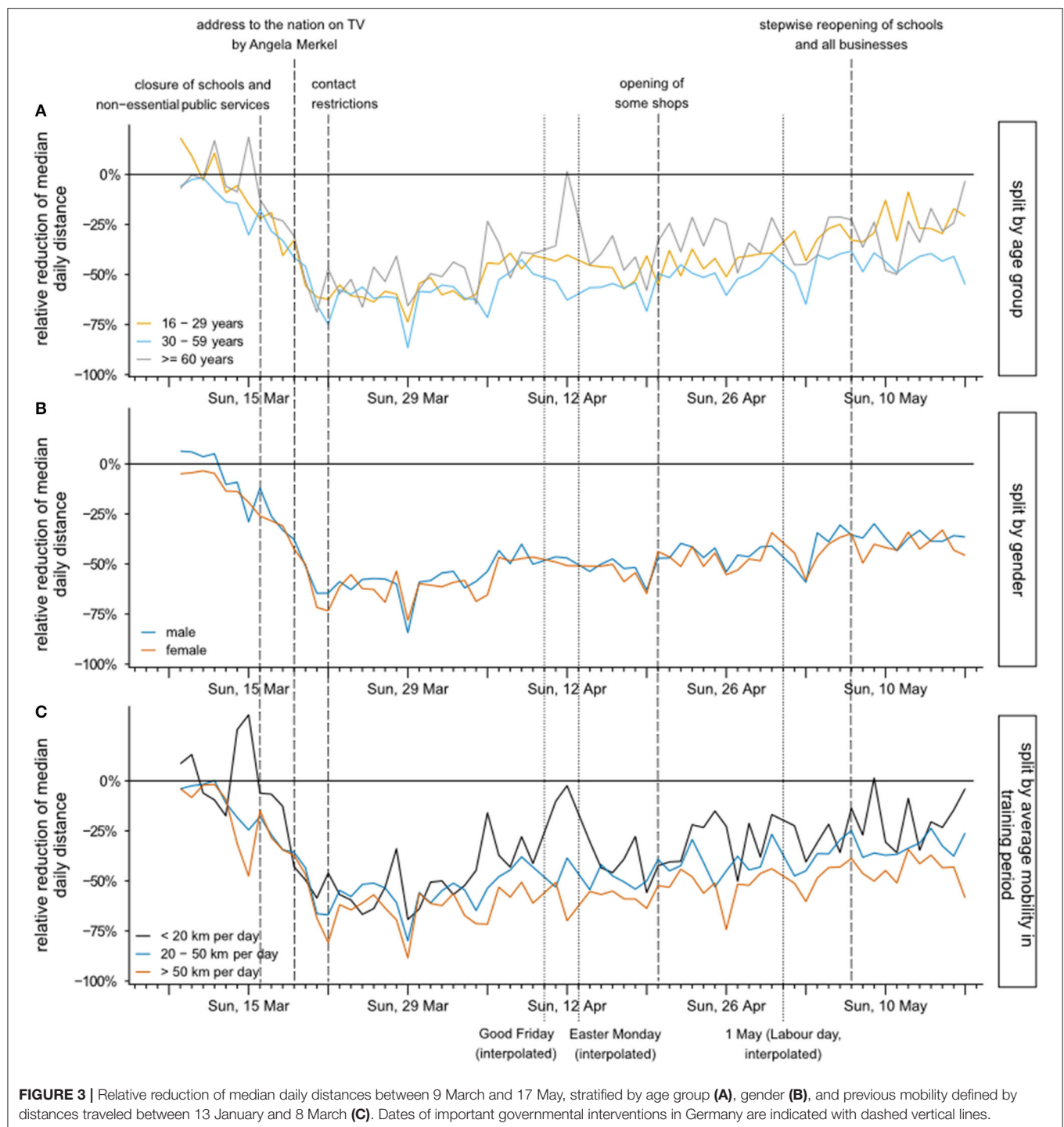
started to increase again, with R remaining stable below one.

This is the first study in Germany in the context of COVID-19 which combines mobility data with individual characteristics and which adds to a number of recent contributions on mobility changes following national mobility and contact restrictions

[e.g., (16, 17)]. Analysis of Chinese mobility data suggests that restrictions were highly effective in reducing mobility and containing the spread of COVID-19 (18). Following the lockdown in Italy, Pepe et al. (19) reported a 50% reduction in mobility within and between provinces measured using large-scale anonymized location data from smartphones. The observed

TABLE 2 | Relative mobility reduction (7-day moving average), daily number of cases (smoothed point estimate), and reproduction number R (point estimate, 7-day value), 6 March to 17 May 2020, Germany.

Date	Mobility[a]	N[b]	R[b]
03/06/2020	−0.01	510	2.35
03/07/2020	−0.01	677	2.57
03/08/2020	−0.02	898	2.94
03/09/2020	−0.03	1,277	3.13
03/10/2020	−0.03	1,729	3.21
03/11/2020	−0.04	2,292	3.11
03/12/2020	−0.06	2,859	2.84
03/13/2020	−0.10	3,448	2.50
03/14/2020	−0.14	3,916	2.18
03/15/2020	−0.19	4,275	1.99
03/16/2020	−0.23	4,879	1.74
03/17/2020	−0.29	5,099	1.56
03/18/2020	−0.36	5,313	1.40
03/19/2020	−0.43	5,329	1.24
03/20/2020	−0.51	5,155	1.13
03/21/2020	−0.58	4,952	1.04
03/22/2020	−0.61	4,581	0.98
03/23/2020	−0.63	4,684	0.92
03/24/2020	−0.62	4,375	0.89
03/25/2020	−0.61	4,370	0.90
03/26/2020	−0.62	4,420	0.88
03/27/2020	−0.63	4,166	0.90
03/28/2020	−0.64	4,117	0.91
03/29/2020	−0.65	3,829	0.90
03/30/2020	−0.63	3,923	0.92
03/31/2020	−0.62	3,787	0.93
04/01/2020	−0.60	3,827	0.93
04/02/2020	−0.59	3,941	0.94
04/03/2020	−0.58	3,776	0.93
04/04/2020	−0.58	3,633	0.92
04/05/2020	−0.56	3,294	0.89
04/06/2020	−0.53	3,197	0.89
04/07/2020	−0.51	3,027	0.87
04/08/2020	−0.49	2,991	0.85
04/09/2020	−0.48	2,987	0.83
04/10/2020	−0.48	2,732	0.80
04/11/2020	−0.49	2,471	0.81
04/12/2020	−0.49	2,243	0.79
04/13/2020	−0.50	2,049	0.79
04/14/2020	−0.51	1,957	0.78
04/15/2020	−0.52	1,937	0.76
04/16/2020	−0.52	1,888	0.78
04/17/2020	−0.53	1,824	0.80
04/18/2020	−0.53	1,695	0.81
04/19/2020	−0.53	1,539	0.84
04/20/2020	−0.51	1,493	0.84
04/21/2020	−0.49	1,419	0.83
04/22/2020	−0.47	1,387	0.83
04/23/2020	−0.46	1,378	0.81

(Continued)

TABLE 2 | Continued

Date	Mobility[a]	N[b]	R[b]
04/24/2020	−0.47	1,273	0.82
04/25/2020	−0.48	1,188	0.83
04/26/2020	−0.49	1,087	0.82
04/27/2020	−0.49	1,045	0.82
04/28/2020	−0.47	992	0.81
04/29/2020	−0.46	956	0.81
04/30/2020	−0.45	965	0.81
05/01/2020	−0.46	890	0.82
05/02/2020	−0.47	836	0.85
05/03/2020	−0.47	810	0.86
05/04/2020	−0.46	801	0.89
05/05/2020	−0.43	805	0.91
05/06/2020	−0.40	809	0.89
05/07/2020	−0.39	795	0.90
05/08/2020	−0.39	740	0.89
05/09/2020	−0.40	681	0.88
05/10/2020	−0.40	634	0.87
05/11/2020	−0.41	623	0.85
05/12/2020	−0.40	608	0.85
05/13/2020	−0.39	607	0.84
05/14/2020	−0.38	597	0.88
05/15/2020	−0.38	601	0.92
05/16/2020	−0.38	585	0.92
05/17/2020	−0.39	549	0.95

[a]*Relative mobility reduction, total cohort, 7-day moving average.*
[b]*Daily number of cases N (point estimate) and reproduction number R (7-day value) from: https://www.rki.de/DE/Content/InfAZ/N/Neuartiges_Coronavirus/Projekte_RKI/Nowcasting.html?nn=13490888.*

FIGURE 4 | Relative mobility reduction vs. reproduction number R (7-day value) from 6 March to 17 May 2020.
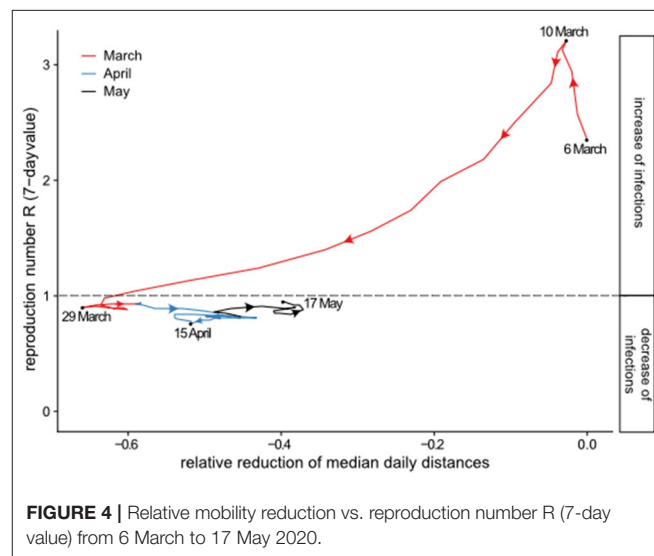
relative reduction in our study fall in the same range. Engle and colleagues combine aggregated mobility, infection, and demographic data at the US County level (20). They estimate that an official stay-at-home restriction reduces average mobility

by 7.87%, which is far less reduction compared to our finding in Germany.

Apart from detailed descriptions of mobility behavior, we provide new evidence on the association between confirmed COVID-19 cases, reproduction number, and individual mobility. The decrease of mobility is rather a surrogate measure for transmission probability than a causal factor for the decrease in case numbers and reproduction number. The fact that the observed increase in mobility in April and May was not followed by an increase of the pandemic indicates that other behavioral changes may have played a major role. Yet, mobility can affect virus transmission dynamics by altering the frequency of contacts between infected and susceptible individuals from different households. Empirical research consistently finds a strong correlation between mobility and the spread and magnitude of various infectious diseases (21, 22). For COVID-19, Kraemer et al. (18) showed that mobility data recording travel in and out of Wuhan predicted very well the total number of cases outside of Wuhan during the early phase of the epidemic.

Our data have several advantages. First, the high spatial and temporal resolution of our tracking data enabled us to study individual mobility patterns at a higher precision than typically achieved with coarse-grained aggregated data from telecommunication or social media providers. Second, our panelists stem from a professionally managed and population-representative panel and explicitly agreed to be tracked for research purposes and voluntarily contributed their profile and location data. This enabled us to conduct detailed analyses of mobility patterns for selected stratifications, to study the influence of socio-demographic predictors on the outcome variable in detail, and to examine heterogeneity in behavior responses. This is in contrast with most other mobile data collection processes.

Following the Interrupted Time Series paradigm, we fitted a seasonal autoregressive time series model to the median daily distances during the reference period and produced mobility forecasts for the evaluation period. These forecasts play the role of a (non-existing) control group not exposed to mobility and contact restrictions, and thus represent the counterfactual scenario from which we deduced relative mobility reduction values. For the time-series analysis we chose the SARIMA $(1, 0, 0) \times (2, 0, 0, 7)$ model, as it showed a good fit and very satisfactory residual diagnostics while being parsimonious enough to avoid overfitting. The SARIMA model captures very well the weekly mobility patterns observed in the pre-intervention period and produces a stable and plausible counterfactual scenario. It could be argued that forecasting the mobility in April and May with a time series model that has been fitted to the data from January to mid-March possibly neglects weather-related effects. However, including such effects would considerably complicate the model without creating additional insights. If anything, including weather effects would further increase the relative mobility reductions obtained in our analysis.

Limitations of our analyses are the preliminarily restricted length of the time series and the possible selection bias due to the structure of the online panel. We are aware that our sample cannot be considered as a representative sample of the population. On the other hand, while our sample may not allow the unbiased estimation of the absolute mobility pattern in the German population, we consider it unlikely that the changes of mobility as observed in our sample are different. This is similar to the reasoning in a cohort study where the observed effect estimate of a factor on the disease risk may be unbiased even if the prevalence of the factor is smaller or larger than in the target population. Furthermore, reduced mobility is only a proxy for the reduction of social contacts and no causal prove for reduced viral transmission. However, the observed reduced mobility was parallel to the general rules to restrict meetings in public and in privacy with other people, to keep distance, and to take sanitary measures like frequent handwashing. Valid prediction models have to include further measures of behavior changes.

It remains to be seen how the course of the pandemic, the restrictions on mobility, and the behavior of the population will develop further. Ongoing analyses may help to select or develop effective measures adapted to different target populations.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

AUTHOR CONTRIBUTIONS

SB analyzed the data and calculated the models. KW supervised and conceptualized statistical modeling and interpreted the results. LK interpreted the results, created the figures, and wrote the manuscript. SS and AZ interpreted the results. SW performed literature research and wrote the manuscript. HB and SM had the study idea and conceptualized the study. All authors contributed to writing the manuscript.

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A Framework for Improving Policy Priorities in Managing COVID-19 Challenges in Developing Countries

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The COVID-19 pandemic has brought unprecedented challenges to societies and threatened humanity and global resilience. All countries are challenged, but low-income and developing countries are facing a more challenging situation than others due to their limited health infrastructure, limited financial and human resources, and limited capacity of governments to respond. Further, the interconnected nature of the COVID-19 pandemic crisis demands an integrated approach and coordinated action, which complicates decision making even more. Identifying the best set of policies and instruments to address COVID-19 challenges, and aligning them with broader social goals will be critically important for sustainable recovery from the pandemic. The key practical challenge facing the policy makers of developing countries is how to prioritize policies to achieve the interconnected goals of managing the health crisis, recovering the economy, and achieving environmental sustainability. We present a framework for identifying and prioritizing policy actions to address the COVID-19 challenges and ensure sustainable recovery. The framework outlines principles and criteria and provides insights into developing shared policy goals, identifying smart strategies, assessing policy compatibility, aligning policy instruments, and factoring sustainability into short and long-term policy decisions. This framework can assist policy makers in linking short and long-term goals, mapping the interactions of different policy options, and assessing anticipated consequences and cross-sectoral implications. This will enable policy makers to prioritize policy choices and allocate limited resources in such a way that they are directed toward actions that generate synergy and co-benefits, have multiplier effects, and achieve interconnected solutions for health, the economy and environment.

Keywords: COVID-19 pandemic, health crisis, developing countries, policy prioritization, policy coordination, sustainability

INTRODUCTION

From a health crisis, the COVID-19 pandemic has become a "systemic global risk" (1). The virus is highly contagious and spreading fast. It does not recognize borders, spares no one, and permeates all aspects of our lives and well-being. It has affected healthcare and economic and social norms and values, has taken many lives, and has threatened the livelihoods of billions of people. It has brought unprecedented challenges to societies and threatened humanity and global resilience. All countries are challenged, but low-income and developing countries are facing a more challenging situation

than others due to their limited health care facilities, low human capital, high poverty, and limited capacity of governments to respond effectively to such a pandemic (2).

Many developing countries have poor health care systems; more than 70% are among those "least prepared" for a pandemic with a global health security index score of <40 out of a 100 (3). In South Asia, Afghanistan has only 2.8 physicians per 10,000 people, Bhutan 3.8, Bangladesh 5.3, and Nepal 6.5, a tenth of the number in more advanced countries. Even India, which has one of the strongest health systems in the region, has only 7.8 physicians per 10,000 people (3). The situation is even worse in many African countries. And there are similar problems with health facilities and physical and human resources. For example, Malawi has only 25 critical care beds for 19 million people and many counties in Kenya have no functioning ventilators (4).

In most developing countries, the challenges of coping with and slowing the pandemic are compounded by adverse social conditions. Not only are the health care systems weak, many people have no health insurance or social security (1). Two of three workers are in the informal economy with no employment contract or social security and only limited or no savings to meet healthcare costs or even basic human needs during the lockdown period without borrowing or selling productive assets (5). In many countries, people lack access to basic services such as clean water, sanitation, and hygiene facilities. For example, close to 42% of households in Afghanistan are compelled to use unsafe drinking water and more than 50% do not have access to water and soap for washing hands (1). Furthermore, high population densities, poor working conditions, and inadequate living space make social distancing very difficult. About a billion people, most of them in developing countries live in urban slums and informal settlements (6–8). Many of these are home to huge numbers of people, for example the Orangi area in Karachi, Pakistan (2.5 million), Dharavi in Mumbai, India (1 million), Neza in Mexico (1.2 million), Kibera in Kenya (0.7 million), Khayelitsha in Cape Town, South Africa (0.4 million), and the Rohingya camps in Cox's Bazaar, Bangladesh (about 1 million). These overcrowded living spaces and limited—often shared—water and sanitation facilities have made physical distancing and self-isolation difficult and increased the risk of exposure and vulnerabilities.

With weak health infrastructure and limited financial and human resources, strategic thinking and planning and setting priorities for policies and activities will be critically important for developing countries to manage COVID-19 challenges (1, 2, 9). Identification of policy priorities and selection of appropriate policy instruments is one of the more powerful means for policy success (10). However, decision making and prioritization has always been a challenge, and the uncertain and volatile nature of the COVID-19 crisis has further complicated the issue (1, 2, 11–13). Further, the interconnected nature of the crisis demands an integrated approach and coordinated action, which complicates decision making even more (14, 15). The key practical challenge facing the policy makers of developing countries is how to prioritize policies to achieve interconnected goals of achieving health and well-being (9, 16). A clear framework will be needed to ensure effective policy development and prioritization in planning and management of their response. In the following, we

suggest an approach and framework that can enable developing countries to develop an effective prioritization process.

A FRAMEWORK FOR PRIORITIZING POLICIES AND IMPROVING POLICY COHERENCE

The starting point in setting priorities should lie in engaging and consulting with key stakeholders in order to create a common vision for health, well-being, economic security, and environmental safety, with buy-in from stakeholders and commitment on broad social goals, which is key for implementation effectiveness. The suggested steps are outlined below and the key elements and supporting structures are presented in **Figure 1**. The framework is developed drawing concepts from public administration, public health, economics, and sustainable development and intended to assist policy makers to weigh policy options and prioritize policy choices within health and outside health sectors for governing complex interconnected issues. There are two major prerequisites for using the framework. The first is to establish a cross-sectoral coordination body, and the second to establish the criteria for assessing and prioritizing policy actions. The principles and criteria for setting priorities identified below are the fundamental basis for weighing different policy choices. These four criteria are at the center of the framework and related to all four steps. The individual elements are described in more detail in the following sections.

Establishing a Multi-Sectoral Coordination Body and Mechanism

Leadership is critically important for effectively dealing health crisis like pandemic as well as engaging and coordination diverse actions and stakeholder in achieving broader social goals (17). A multi-sectoral coordination body can provide an effective pathway for engaging multiple stakeholders, and the basis for a mechanism for coordinating and steering the decision-making process, and overseeing the implementation and recovery packages to maximize impact (18). Many agencies important for health crisis management work within the health system, ranging from health education to prevention, and protection to treatment. Outside the health system, food and nutrition, water and sanitation, housing, and elements of the physical environment such as air quality and climate are important for maintaining, improving, and protecting health (11, 12, 19). A coordination body could establish a mechanism and develop a protocol for coordinating both the administrative (functional) and the policy (strategic) activities of the different organizations. While the focus of functional coordination could be on building consensus and ensuring smooth cooperation within and between the key organizations involved in the planning process, policy coordination should focus on improving policy coherence and developing consistent policies to improve synergies. Effective administrative coordination is a precondition for successful policy coordination. While detailed consultation is not possible during a time of urgency like the COVID-19 pandemic, this body
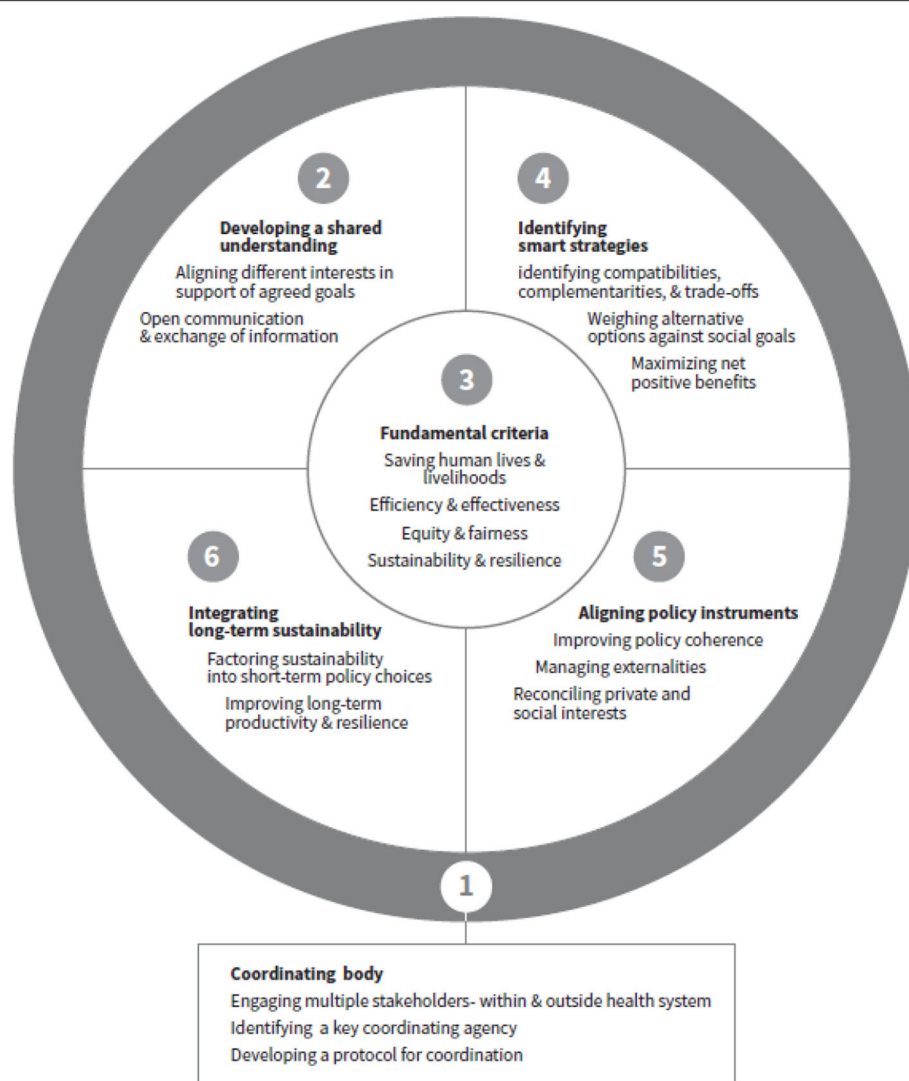
FIGURE 1 | A framework for prioritizing policy choices.

should be able to engage and consult with key organizations and stakeholders in order to facilitate exchange of ideas, dialogue, and discussion, and provide strategic directions and clear guidelines in setting priorities, allocating resources, and implementation. The key stakeholders could be key government agencies such as health (including public health experts), finance, security, water, food, and trade and commerce, as well as experts and development partners, think tanks, and both government and non-government actors. Effective stakeholder engagement relies on appropriate institutional frameworks as well as effective use of both formal and informal coordination mechanisms to facilitate mutual communication and collaboration among stakeholders and oversee the priority setting process (18, 20, 21). The overall coordination can remain under the cabinet or national planning commission (who have the authority to mobilize sectoral ministries and agencies), or an inter-ministerial committee. However, this can vary considerably from country to

country depending on the cultural context and administrative and operational capacity (13). It could be a single structure or unit such as the Ministry of Health or the Office of the Prime Minister or President or Planning Commission. However, it is critically important to identify a key coordinating agency within the current institutional framework, which has the authority to convene and coordinate multi-sectoral actions and guide integrated planning. The coordination body should have broad representation and may include both political leaders and experts in the relevant fields, and should have adequate convening and decision-making power and authority, as well as the capability to deal with strategic issues including policy coordination. This requires a continuous process of analyzing, balancing, and prioritizing the objectives of different policy goals. It may also require enhancing institutional capacity, including the operational and coordination skills of coordination agencies, and improving processes that facilitate engagement with stakeholders

beyond governments, such as private health service providers and other non-state actors (20, 21). In striving to establish multi-sectoral coordination, it is also important to distribute responsibility and establish mechanisms for regular interaction among key stakeholders in order to build inter-organizational trust and promote communication and share knowledge and information among key institutional agencies.

Developing a Shared Understanding and Objectives

One of the fundamental steps (**Figure 1**) in the planning and prioritization process is breaking sectoral silos and aligning interest of different agencies to develop a shared understanding on policy goals and strategic objectives and short and long-term needs of a country (18). This provides the basis for achieving a consensus on multi-pronged strategies to achieve short-, medium-, and long-term goals. To avoid conflicts, decision making on strategic policy choices and programs needs to be mindful of the broader social goals and their potential conflicts. The short-term focus will be on managing the immediate health crisis, ensuring food and nutrition, and short-term job creation to help the economy survive; the medium-term on boosting economic activities to achieve financial and economic recovery; and the long-term on transforming or bouncing the economy forward by promoting long-term sustainable growth, reducing inequalities, building social coherence and resilience, and conserving resources and protecting the planet. The different goals are closely linked and interdependent as health, economic, social, and environmental systems are interconnected (22). The shared policy goals provide a basis for developing practical criteria and guidelines for prioritization.

Building Consensus Among Agencies

Building consensus among agencies within and outside of the health system is a daunting task. It involves engagement with the relevant government agencies and other key stakeholders and reaching societal agreement on common priorities that reflect the views of key stakeholders including epidemiologists and economists (15). This not only provides the fundamental basis for prioritization but also creates buy-in, commitment, and accountability from stakeholders on the broad social goals. Although different government agencies have different interests and priorities, facilitating discussion and consultation, mediating conflicts, building trust, and providing a platform to clarify expectations can enhance mutual understanding and align interests (21). One way to align multiple perspectives and build shared understanding through the process of engagement known as "principled engagement" that fosters reasoned argument (weigh different options and priorities objectively against broad social goals) and deliberation focused on defining problems and finding agreements together (23). It supports shared representation and open interactions of different sectoral actions, and to integrate the concerns and goals of different sectors and agencies. It allows open discussion, surface multiple perspectives, and enables "shared motivation" that build trust, foster mutual recognition of interdependence and shared ownership, and create a sense of internal legitimacy

(23). The principled engagement and shared motivation support each other and create an enabling environment for integrated planning, jointly identifying and defining objectives as well as a collaborative, raising awareness about the complementarities and externalities, and using a coordinated approach to consultation with open communication and exchange of information, will help align multiple perspectives reduce disagreements, increase understanding, and clarify organizational responsibilities (14, 18). Besides the four fundamental criteria presented above, aligning the different interests in support of agreed goals and building consensus through open communication and effective collaboration is critically important for policy prioritization in managing COVID-19 challenges and recovering the economy sustainably. In striving to build a consensus on policy goals and maintaining shared understanding, the interests, needs, and positions of different stakeholders need to be understood and assessed based on the fundamental criteria outlined above.

Agreeing on the Principles and Criteria for Setting Priorities

Priority setting is a complex process involving making decisions on the allocation of resources to improve policy goals. The interests, motivations, and preferences of the diverse array of stakeholders will differ, thus prioritization needs to be based on explicitly chosen and agreed criteria.

Dimension of Priorities

Prioritization is a multidimensional concept and can be seen from different perspectives, all of which need to be understood and taken into account. From a moral and ethical perspective, managing existing, and emerging threats to human lives is a societal obligation and the primary responsibility of states (24, 25). Thus, the highest priority should be given to policy choices that save human lives by reducing health risks, improving health care, reducing communicable diseases, and ensuring provision of basic health services, together with those aimed at meeting basic human needs such as access to food, water, and shelter. From a utilitarian perspective, policy choices should be guided by the utility generated and cost-effectiveness, since resources are finite (26, 27). Thus, the highest priority should be given to the policy choices that are most cost-effective and generate the maximum net social benefits. From an egalitarian perspective, equity, and fairness are equally important in policy choices (28, 29). Cost-effectiveness is important but should not be the sole criterion; an equally high priority is given to protecting those who are most at risk and serving the most deprived even if this is less cost-effective. From a resilience perspective, present actions should prepare for transition to a more resilient and better society (12, 30). Thus, a high priority should be given to policy options that enhance long-term social, economic, and environmental benefits that lay the basis for long term resilience and build the capacity to deal with future challenges.

The basic principles and criteria should be agreed by the key stakeholders and effectively communicated across all stakeholders. Using these broad perspectives, four practical criteria can be identified as the fundamental basis for assessing

and prioritizing policy choices and thus allocating resources (**Figure 1**):

- Saving human lives and livelihoods
- Efficiency and effectiveness
- Equity and fairness
- Sustainability and resilience

These four principles and criteria may vary from country to country and different countries may attach a different weight to the different criteria based on the socio-economic conditions, existing health facilities, financial capacity, and environmental conditions of the country and the specific social, economic, and environmental concerns.

Identifying Smart Strategies That Bring Synergistic Effects

Once agreement has been reached on policies and prioritization criteria, the next step is to develop strategies for integrated and coordinated implementation of the different policy measures (**Figure 1**). It is important to explore complementarities and identify potential co-benefits for the different policy options that bring synergistic effects by achieving multiple objectives at the same time with benefits for both health and economic recovery.

In addition to the fundamental criteria for assessing priorities, developing countries generally prioritize providing jobs and income for the poor and vulnerable (31). Thus, a typical smart strategy could comprise investing in labor-intensive sectors that immediately generate employment while also generating multiplier effects for the economy by increasing growth potential and supporting economic recovery (31, 32). For example, investment in public works, infrastructure, small business, and micro and small enterprises can quickly offer jobs and income while stimulating local economies through using local resources and increasing the demand for manufactured goods (31, 32). The outcome of such strategies, however, will depend on the local conditions and the way in which the programs are designed and implemented.

In addressing the challenges brought by the COVID-19 pandemic, it is important to choose policy options that support, and don't reduce, achieving other strategic objectives (33). Identifying such options involves analyzing the interactions among different strategies, assessing the magnitude and nature of benefits, and identifying compatibilities, complementarities, and trade-offs. For example, access to clean water, sanitation, and hygiene is critically important for addressing the challenge for COVID-19 health risks, so investment in water infrastructure can generate employment and provide health benefits. In contrast, economic activities that pollute water and air undermine efforts toward achieving human health. Similarly, investment in education is key for reducing economic vulnerability and developing resilient systems. Education and health improve human capital, while human capital shapes productivity (34). The World Development Report estimates that those developing countries with low human capital today, will have a future workforce that is only one-third to one-half as productive as a workforce in full health and having a good education (34).

Policy support to empower socially disadvantaged communities to exercise control over the social and economic factors that determine their health can improve long-term health benefits (11). Policy choices that increase access to health and education, develop new skills, improve productivity, improve air, water, and soil quality, conserve natural resources, build adaptive capacity, and reduce inequalities all help to improve socio-economic resilience, whereas policies aimed simply at achieving short-term gain can result in unsustainable practices that reduce long-term adaptive capacity and affect planetary health (32, 35). Policy options that bring synergistic effects with other strategic objectives should get priority. For example, a policy choice to create jobs in rural areas through growing nutritious crops can create jobs for the unemployed in agriculture and also support the objective of achieving good health through nutrition (36). Policy options that constrain achieving other goals or undermine long-term resilience should be avoided or minimized as far as possible.

Improving Policy Coherence

While in certain areas policy cannot be compromised, there are many areas where improving policy coherence and coordination can reduce trade-offs and improve synergies and thus increase the net positive gain to society (19, 32). It is therefore critical to assess the magnitude of trade-offs and find ways and means to minimize them and improve the net positive outcome on the broad social goals outlined in the basic principles. For example, relaxing lockdown may increase the risk of spreading the virus, but properly regulated may save the jobs and livelihoods of large numbers of poor people. If the livelihood benefits outweigh the calibrated risk, then the net positive benefit may increase. This approach can be useful in identifying alternative approaches and combinations of measures and weighing the potential benefits and externalities both positives and negatives to maximize net social benefits in achieving the broad social goals. **Table 1** shows an example of qualitative assessment of different policy options to maximize complementary effects and minimize counter-productive effects in order to enhance the net societal benefits (**Table 1**).

In additional to the fundamental criteria outlined above of potential societal benefits, externalities, and scale of positive and negative effects, three additional criteria should be taken into account in the selection of policies and investment decisions—coherence, compatibility, and congruence.

- **Coherence** is needed both among the different health related policy goals, and between these and any policies outside the health sector whose action may affect the outcome of the health sector goals. Ideally, the selected policies should contribute to achieving multiple policy goals
- **Compatibility** of policy options refers to the consistency in how they reinforce or undermine related policy goals and externalities and is needed to enable policies to contribute to achieving multiple health-related goals.
- **Congruence** refers to the ability of policy options and strategies to work together in a mutually supportive manner to help attain health sector and health-related non-health sector goals

Proposed activities	Potential societal benefits			Externalities		Scale of effects (positive/negative)		
	Health	Economic	Environment	+/– ve effects	– ve effects	Short	Medium	Long
Imposing lockdown	+	–	+	+/–	–	+	–	+/–
Increasing investment in health care	+	+	+	+/o	0	+	+	+
Increasing investment in education, skills development	+	+		+/o	0	+	+	+
Creating jobs in public construction of water infrastructure	+	+	+	+/o	0	+	+	+
Creating jobs in growing nutritious crops	+	+	+	+/o	0	+	+	+
Supporting jobs in growing tobacco for cash income	–	+	–	–	–	+	–	–
Withdrawing trade barriers	+	+	+/–	+		+	+	+
Subsidizing airline industries	–	+	–	–	–	+	–	–
Policies for withdrawing subsidies on fossil fuels	+	+/–	+	+		+/–	+	+

*+, positive effect; –, negative effect; o, no relationship; **+** ve, positive externalities; **–** ve, negative externalities.*

Aligning Policy Instruments to Improve Policy Coherence

Governments can use different policy instruments (the financial, regulatory, and market tools used to influence people's choices and behavior) and shape the incentive structure to achieve the desired social goals (10). Once the policy options to be implemented have been identified using a smart strategy approach, the best policy instruments need to be chosen and strategies and instruments aligned to maximize the potential for success in achieving the broad social goals in addition to the fundamental principles and criteria agreed (**Figure 1**).

Improving Policy Coherence

One way to align policy instruments is to improve policy coherence across health, economic, social, and environmental goals so that the policy instruments of one objective do not undermine those of another (15, 33). For example, supporting employment through growing tobacco for cash income in rural areas may increase income but can hinder the goal of achieving good health. Likewise, subsidizing chemical fertilizers and pesticides to increase crop productivity might result in water and air pollution and thus also defeat the goal of achieving good health (12). Similarly, encouraging plantation of erosive crops like cassava in a hill area to provide higher incomes in the short term, may exacerbate soil erosion and land degradation and undermine productivity and sustainability in the long-term.

Managing Externalities

Another way to improve policy coherence is to manage externalities. A positive (beneficial) or negative (harmful) externality is the consequence of an industrial or commercial activity which affects other parties without this being reflected

in market prices (10, 37). For example, when bees kept for honey pollinate surrounding crops there is a positive externality for the owner of the crops. However, when industrial waste pollutes a water source and affects and pollutes fish stocks, downstream fisher communities experience a negative externality that reduces income and impacts health. Negative externalities resulting from production processes can include environmental pollution, overexploitation of natural resources, and degradation of ecosystems, all of which can affect the natural environment and planetary health, which in turn are closely related to human health (35, 38, 39).

Externalities arise because decisions on production or consumption of goods or services taken by a private investor or consumer are not designed to take into account the broader social consequences as these are not reflected in the market price (10). Conventional market mechanisms, and thus prices, are not designed to reflect the costs and benefits of social goods and services (for example costs of disposing of waste, of addressing environmental pollution, of treating ill health caused by a product) unless required by statutory instruments (such as a surcharge or tax related to disposal costs or health impact). Designing policy instruments to maximize positive and minimize negative externalities can be instrumental for achieving broad social goals (12). Policy instruments need to be chosen that create disincentives for negative externalities through taxes, fines, or fees, and encourage positive externalities through subsidies, rewards or other incentives.

Reconciling Private and Social Interests

Another result of private decision makers not being required to consider the broader social consequences of their decisions is that social goods tend to be under produced and private goods over

produced (19, 37). The divergence of private and social interests often leads to sub-optimal production of social goods such as public health, public transport, clean air, clean water, education, research, and innovation, which generate positive externalities for society. Private investors cannot directly capture the full benefits generated through social goods and thus investment in social goods lies outside their interests. However, it is difficult for governments to deliver the required social goods alone, and private sector participation is important for filling the gap between public need and financial capacity. Appropriate incentive mechanisms can be developed to encourage private investment in social goods, including improvements in the healthcare system (37, 40). Choices that internalize such external costs should be considered carefully and prioritized. When incentives are not enough, policy reforms that regulate the unsustainable use of resources and impose standards and procedures to internalize external costs and control pollution should be prioritized. For example, regulating trade in wild animals and direct contact with animal parts reduces the exposure of humans to contact with viruses and other pathogens hosted by those species. Similarly, raising the cost of fossil fuels can help in reducing air pollution and improving air quality, while providing subsidies for private intensive care units can reduce investment requirements, and thus support public health provision (12). Different types of policy instruments that reconcile private and social interests, from incentive-based mechanisms to regulation, should be prioritized.

Thus, it is critically important to select the policy instruments strategically and arrange them carefully so that they work together and are mutually supportive in reaching health-related policy goals. Considerations on policy tools can involve purposeful arrangements of policy instruments in such a way as to generate positive interactions between them. However, in choosing policy instruments, the cultural and operational capacity needs to be considered carefully as different instruments require different levels of operational capacity to implement and not all instruments are feasible in every socio-cultural context (13).

Integrating Long-Term Sustainability in Policy Decisions

No matter what challenges need to be addressed in the short-term, government policies and actions should take into account the need for sustainability in the long-term. Thus, policy choices should focus both on resolving urgent needs and on ensuring long-term resilience and sustainability while taking to account the fundamental principles and criteria agreed as the fundamental basis (**Figure 1**).

Factoring Sustainability Into Short-Term Policy Choices

The COVID-19 pandemic provides an opportunity to take a broad look at factoring sustainability—economic, social, and environmental—into policy choices in order to create more resilient societies (35, 38). This requires strategic thinking and a systematic assessment of policy options and strategies for long-term investment to ensure that the short-term actions result

in long-term benefits. Some of the short-term support can be linked to long-term economic growth by appropriate conditions that improve the social and environmental conditions for health (12, 41). For example, food for work programs can be attached to programs for adapting or constructing local infrastructure to maintain social distancing, thus helping poor households to cope with vulnerability while building assets that are essential for society. Similarly, requirements to include energy efficiency in building designs can be linked to support provided to building construction companies to restore jobs, thus providing job restoration in the short-term and climate benefits in the long-term.

Improving Long-Term Productivity and Resilience

The short-term focus will be on addressing the impacts of the pandemic and, following the direct health-related activities, is likely to focus on employment generation and restoration of jobs. However, long-term investment decisions should also be considered. Investing in a balanced portfolio of physical, human, social and natural capital will help improve long-term productivity and resilience, and thus build capacity to deal with future challenges and mitigate the impact of future pandemics and disasters (12, 41, 42). For example, investment in health, education, skills development, innovation, technological upgrading, and green infrastructure and natural capital will increase productive capacity and provide sustainable returns for future generations (11, 19). Investment in social protection and job creation will be needed to protect the vulnerable in the short term, but policy priorities could gradually shift to reducing the environmental risks affecting human health and vulnerability to climate change. Protecting and enhancing natural capital such as forests, soils, water resources, ecosystems, biodiversity, air quality, and climate can support human health and productivity and improve long-term resilience (41, 43). For example, investment in green infrastructure such as renewable energy can supply clean energy and improve air quality, which leads to long-term health benefits and positive climate outcomes (39).

In striving for sustainability, policy choices, and investment decisions should be arranged strategically in such a way that they not only address immediate problems but also build long-term resilience.

CONCLUSION

Identifying the best set of policies and instruments to address COVID-19 challenges and aligning them with broader social goals will be critically important for sustainable recovery from the pandemic and resilient society. The way in which governments set their priorities, prioritize policies and programs, and coordinate activities will affect the outcome. Poorly identified policy choices are likely to be ineffective in addressing the health, economic, social, and environmental challenges and harnessing the potential long-term economic and environmental benefits. This paper presents a framework for identifying and prioritizing policy actions to address the COVID-19 challenges and ensure sustainable recovery. The framework outlines

principles and criteria, and a suggested approach, for assessing and prioritizing policy choices in planning and decision making. It offers guidelines for developing shared policy goals, identifying smart strategies, aligning policy instruments, and factoring sustainability into short and long-term policy decisions.

In contrast to the common practice of evaluating policy outcomes after implementation, this framework enables policy makers to think ahead and assess the anticipated consequences of different policy options and their positive and negative cross-sectoral implications, which is critically important for developing a coherent and integrated set of policy decisions in the uncertain volatile situation of the COVID-19 pandemic. The framework can help governments to prioritize policy choices and allocate limited resources in such a way that they are directed toward actions that generate synergy and co-benefits, have multiplier effects, and achieve interconnected solutions for health, the economy, and the environment.

Enhancing cross-sectoral integration and improving policy coherence is a challenging task requiring strong commitment from governments. A major prerequisite for using the framework is to establish a multi-sectoral coordination body with the capacity to mobilize and build partnership, consensus, and ownership among the multiple government and non-government agencies and thus increase horizontal and vertical policy coherence and strengthen policy coordination for collective action. The suggested framework is generic, and could be further developed using quantitative tools for detailed analysis and quantification of the complementarities and trade-offs presented in **Table 1**. Although this framework is intended to address COVID-19 challenges, this can be customized and used in different policy arenas in managing cross-sectoral and interconnected challenges. Cross-sectoral collaboration and problem solving is demanding knowledge and capacity in managing inter-sectoral dynamics. In designing the detailed policies and strategies, cultural values, and operational capacity—including leadership, coordination, and implementation—and political realities will need to be considered (13).

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

AUTHOR CONTRIBUTIONS

The author confirms being the sole contributor of this work and has approved it for publication.

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Voluntary Cyclical Distancing: A Potential Alternative to Constant Level Mandatory Social Distancing, Relying on an "Infection Weather Report"

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COVID-19 has significantly changed our daily lives. Stay-at-home orders and forced closings of all non-essential businesses had a significant impact on our economy. While it is important to ensure that the healthcare system is not overwhelmed, there are many questions that remain about the efficacy of extreme social distancing, and whether there are alternatives to mandatory lockdowns. This paper analyzes the utility of various levels of social distancing, and suggests an alternative approach using voluntary distancing informed by an infectious load index or "infection weather report."

Keywords: social distancing, public information access, voluntary action, behavior modification, behavior model

1. INTRODUCTION

The outbreak of SARS-CoV-2 has caused a lot of changes in our daily lives. When policy makers around the world realized the threat of COVID-19, they began crafting guidance, and eventually started issuing stay-at-home orders. These orders have created significant economic disruption, and disruption to peoples' lives. And there has been a question of how long they can be maintained. Already, lock-down orders are being lifted, at least in part, in some locations. But the question remains of what to do next, both in terms of dealing with the spread of SARS-CoV-2, and handling any future outbreaks of this nature.

Many of us are familiar with the catchphrase "flatten the curve." The idea is that social distancing will reduce the rate at which the infection spreads, and thus reduce the burden on the healthcare system. However, these lockdown orders cannot be maintained indefinitely. One has to wonder how a premature end to a lockdown might impact the spread of the infection, and if there are any alternatives to such measures, and whether they might be more effective.

This paper has two goals. The first goal is to compare a number of modified SEIR models, in order to identify possible outcomes associated with the current lockdown efforts. The second goal is to identify potential ways to improve efforts to reduce the spread of both SARS-CoV-2, and infectious disease overall. The models in this paper rely on empirically estimated parameters, and take into account a number of factors, including social distancing, stratification of risk groups and hospital capacity. It then compares models in which a constant level of social distancing for a fixed period of time with modulated social distancing based on voluntary activity informed by disease surveillance.

2. MODEL DEVELOPMENT

The core of these analysis is the SEIR compartmental model. Many alterations to the basic model have been made. There are two copies of each compartment, one for low risk individuals, such as young people with minimal comorbidities, and one for high risk individuals, such as the elderly and people suffering from various diseases or are otherwise in significantly poor health. For simplification, the focus for risk was on age. Mortality rates were also considered.

2.1. Base

The core model for each set of compartments is defined as follows:

$$\dot{S} = -\rho\beta SI$$
$$\dot{E} = \rho\beta SI - \alpha E$$
$$\dot{I} = \alpha E - \gamma I - \mu I$$
$$\dot{R} = \gamma I$$
$$\dot{M} = \mu I$$
$$N = S + E + I + R + M$$

Here β is the product of the contact and transmission rates. α is the reciprocal of the incubation period, γ is the reciprocal of the clearing period post-onset of symptoms, and μ is the mortality rate. And ρ is the adjustment to the contact rate, due to social distancing. Each of these cells are duplicated into a low risk and high risk set. For social distancing, it is assumed that there will be a greater amount of social distancing within the high risk population and between the low and high risk populations.

2.2. Data Sources and Estimates

2.2.1. SEIR Parameters

Approximation of basic parameters comes from a number of sources. According to Peng et al., the latent time period, or the time it takes for a person to transition from exposed to infected, is ~2 days, giving $\alpha = 0.5$ (1). The analysis also suggests that every contact is almost guaranteed to result in an infection: $\beta \approx 1$. Because the model used in Peng et al. was complicated and did not calculate the unaided clearing of the infection, approximations from another source were used. D'Arienzo and Coniglio suggest that even in Italy where there is a significant COVID-19 burden, the basic reproduction number is between 2.43 and 3.10, which yields a range of 0.32 and 0.41 and for γ (2).

While β is approximated as 1, it is unlikely that the contact rates of individuals within the same age group is equal to the contact rate of individuals between the two groups. It is likely that within-group contact rate is higher than average, and that the between-group contact rates are lower than average. People within the high risk group are also more likely in general to maintain social distancing, and so this idea is also considered in approximating β for each type of interaction. Values were chosen s.t. the population weighted average summed to 1.

2.2.2. Demographics

It was assumed that 84% of the population was in the low risk group and 16% was in the high risk group, and that there was one initial infection within each sub-population. This assumption is based on the fraction of the United States population aged 65 or older in 2018 (3). The United States population was slightly under 330M in 2018, so 330M was chosen for N (3).

2.2.3. Hospital Capacity and Mortality Rates

Hospital bed capacity is estimated based on figures from COVIDACTNOW. The model assumes that there are roughly enough hospital beds for 0.22% of the population, with 60% capacity, and an emergency capacity build of roughly 200% (4). As a conservative estimate, 0.1% was chosen for the capacity limit.

Infection and case fatality rates are highly dependent on a number of factors and vary based on the quality of the health care system, the age of the patient, and comorbidity. Mortality seems to be orders of magnitude higher in at risk populations compared to low risk populations. COVIDACTNOW estimates a case fatality rate of 1.1% with an additional 1% if hospitals are overburdened (4). However, it does not stratify by risk group.

The base model starts with the assumption that the case fatality rate is 0.1% for low risk populations and 10% for high risk populations. Assuming that being over-capacity increases the risk of death among the low risk population by 50% and the high risk by 200%, that would yield a case fatality rate of 0.15 and 30%, respectively. The 50% figure is still higher than the relative risk at 10 days, for general ER visits, but within the 95% CI of 1.04–1.72 (5).

However, not every infection meets the criteria of being a case. There are many asymptomatic and subclinical infections for SARS-CoV-2. By one estimate, the number of infections was 50–85 times higher than the reported number of cases (6). However, it's quite possible that a number of those infections resulted in deaths that were not reported. Furthermore, since it is more likely that high risk individuals are more likely to show dangerous symptoms, and their status as being high risk yields a greater rate of testing, the mortality rates of the high risk group received a smaller adjustment. Low risk mortality rates were divided by 20 and high risk mortality rates were divided by 5.

2.3. Parameters

N = 330,000,000

$\alpha = 0.5$

$\beta_1 = 1.075$—The adjusted contact-transmission rate within the healthy population

$\beta_2 = 0.75$—The adjusted contact-transmission rate between both populations

$\beta_3 = 0.9$—The adjusted contact-transmission rate within the high risk population

$\gamma = 0.37$—Average between the low and high bound estimates for the clearing rate

$\rho = [variable]$—The base social distancing coefficient

$\rho_1 = \rho$—Social distancing coefficient for low risk group

$\rho_2 = 0.8\rho$—Social distancing coefficient between the low and high risk groups

$\rho_3 = 0.8\rho$—Social distancing coefficient for high risk group

$\mu_1 = 0.00005$—Mortality rate of low risk group under optimal conditions

$\mu_2 = 0.02$—Mortality rate of high risk group under optimal conditions

$\mu_3 = 0.000075$—Mortality rate of low risk group under sub-optimal conditions

$\mu_4 = 0.06$—Mortality rate of high risk group under sub-optimal conditions

$\kappa = 0.001$—Percent of population infected before hospitals are over capacity.

3. MODELS AND MODEL ANALYSIS

A number of analyses were performed. First, it seemed useful to simulate how different levels of social distancing impacted the progression of the epidemic, when social distancing is maintained for a fixed period time period of 60 days, with initial onset 60 days after the first infection, representing lag between initial discovery of the disease and decision to engage in mandatory social distancing.

3.1. Relative Mortality Across Social Distancing Parameters

Figure 1 is an analysis of relative mortality rates across various social distancing parameters. For social distancing parameters ranging from 0.1, representing extreme social distancing, to 1, representing no social distancing, a social distancing parameter of 0.65 appeared most effective, with an approximate reduction in mortality of 40%. A social distancing coefficient of <0.65 caused an uptick in mortality rates from that low. The minimum estimated mortality rate, for the entire progression of the epidemic was ∼0.0062 or 620 per 100,000. For the United States, that would imply a final death toll of ∼2 million under moderate social distancing, and 3.3 million without any social distancing.

Looking at the progression of the epidemic, for $\rho = 0.4$ (**Figure 2**) helps to understand why values <0.7 result in higher mortality rates. Each time step represents 0.1 days. At the start of the outbreak, there is a significant reduction in infections and deaths, but there is a spike in both shortly after the end of the social distancing effort. Rather than flattening the curve, the more extreme social distancing measures appear to delay the peak, allowing "pressure" to build up due to a high reserve of susceptible individuals. In order for more extreme continuous social distancing measures to be effective, they would therefore have to be maintained until an alternative, such as a vaccine, is produced.

3.2. Epidemic Backdraft Effect

An initial preprint of this article predicted that extreme lockdowns would delay, rather than flatten the pandemic curve (7). A new apparent wave of epidemics began to emerge sometime after lockdowns ended in various regions. A number of states, including California and Florida, have seen rapid surges in case rates (8, 9). California responded with a rollback of reopenings, and New Jersey delayed reopening (10, 11).

Some individuals have suggested that these surges are due to the infection unevenly spreading across regions in the United States, moving around as states unevenly relax their lockdowns (12). At first, this explanation seems reasonable. However, other nations have seen a resurgence in COVID-19 cases as well. Australia has recently seen a large spike in cases. In Early July, Victoria, Australia saw a surge in cases, leading to a second lockdown of the state (13). This surge comes less than two months after Australian Finance Minister, Mathias Cormann, claimed that Australia was wining against the virus (14). Another explanation put forward is that people had been too flippant in their activities as lockdowns were eased. Young people began frequenting bars again, while many others flocked to beaches (15, 16). And indeed, cases have grown in number in Florida, as already mentioned.

Admittedly, these actions likely contributed to new outbreaks, but does not do enough to explain the timing or why they are occurring in so many locations. Furthermore, these reckless actions were likely fueled by the extreme nature of the lockdowns. The model proposed in this article helps fill in that gap in our understanding of the issue. The extreme lockdowns appear to have done little to stop the epidemic. They merely introduced a delay. As lockdowns eased, the large body of remaining susceptible individuals began coming into contact with the remaining infected individuals, and the epidemic began following its original trajectory. Furthermore, extreme social distancing left individuals starved for contact. This lockdown fatigue increased social contact fueling additional infections. This phenomenon is important enough to merit its own name: epidemic backdrafts. A backdraft occurs when low oxygen levels suppress an active fire, but fail to fully extinguish some remaining embers, leaving the embers to generate flammable gasses; when oxygen is reintroduced to the environment, the fire quickly reignites (17).

In a similar way, extreme social distancing measures prevent an infection from spreading, but leave a large percentage of the population susceptible. Moreover, the lockdowns generate the equivalent of combustible gasses, in the form of social agitation and growing desire to reconnect with others. In cases where there are still remaining members of the epidemic when the lockdowns end, an epidemic backdraft occurs, leading to a rapid flare up of the infection.

3.3. Cyclical Distancing

As early as the beginning of April, it became apparent that a one time social distancing effort may be not be enough to cope with the COVID-19 epidemic (18). However, Kissler et al., while recognizing this issue, did not seek to establish a specific protocol for when social distancing should be engaged and disengaged (18). Some governments have started to create checklists of desired observations before reopening of businesses can begin. New York, for instance, created a seven point checklist (19).

Unfortunately these types of checklists suffer from two fundamental issues. The first is that they are only actionable by the governments that have created them. They do little to allow the people to make decisions which can improve their safety. The second issue is that the actions that they inform are all or nothing events: either a region opens or it does not. The checklist system might be a good start, but it would be helpful if the aforementioned weaknesses could be addressed. Assuming that it is possible to obtain reasonably high resolution data for a region, the public health community should be able to put out daily and weekly advisories. These advisories can be used to promote voluntary social distancing, during periods of high levels of infectious load.
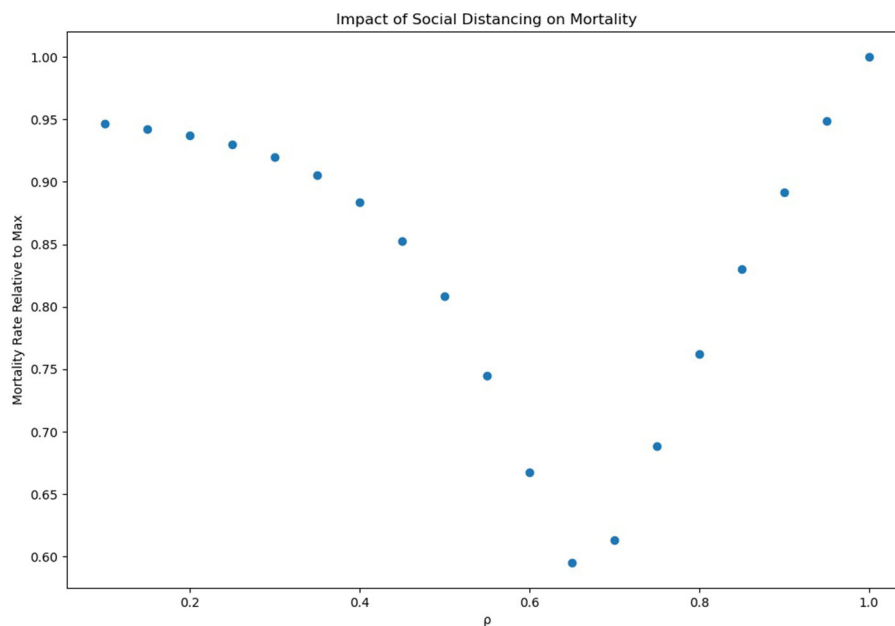
FIGURE 1 | Mortality relative to base mortality.
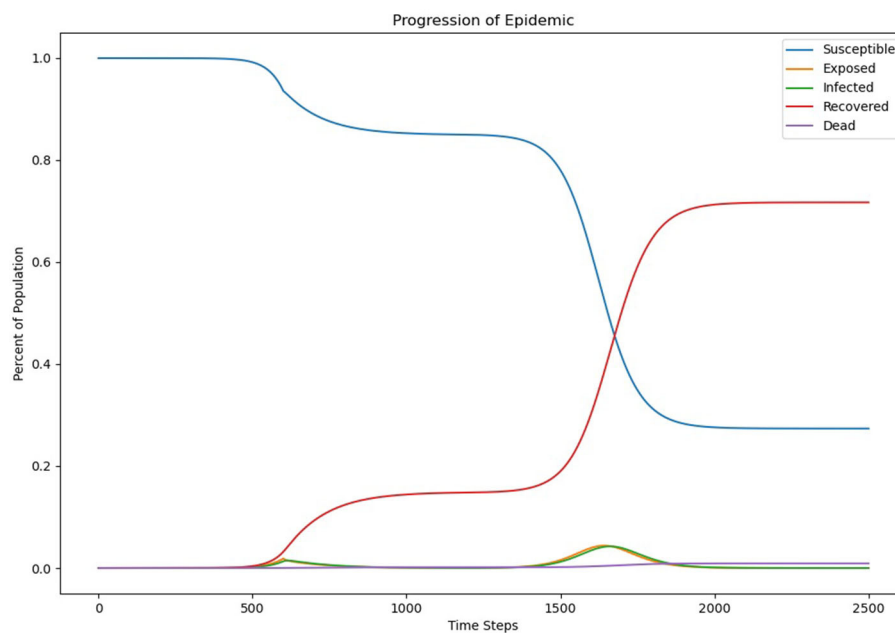
FIGURE 2 | Epidemic progression with $\rho = 0.4$.

Because the social distancing measures would be temporary, and because there would be less uncertainty, because of the clear conditions for distancing recommendations, a slightly more extreme level of social distancing should be possible, so a $\rho = 0.5$ was chosen. A threshold of 0.0005 for the 7 days moving average of infections was chosen, because it was half the estimated maximum safe load that hospitals could handle.

Furthermore, because reports of low infectious load could yield a false sense of safety, $\rho = 1.05$ was chosen during periods when social distancing was not engaged. The graphical results of the voluntary cyclical distancing model are detailed in **Figure 3**.

The results of the analysis are interesting. Voluntary cyclical social distancing, using the parameters chosen, results in a significantly extended curve. It takes around 1,200 days for the
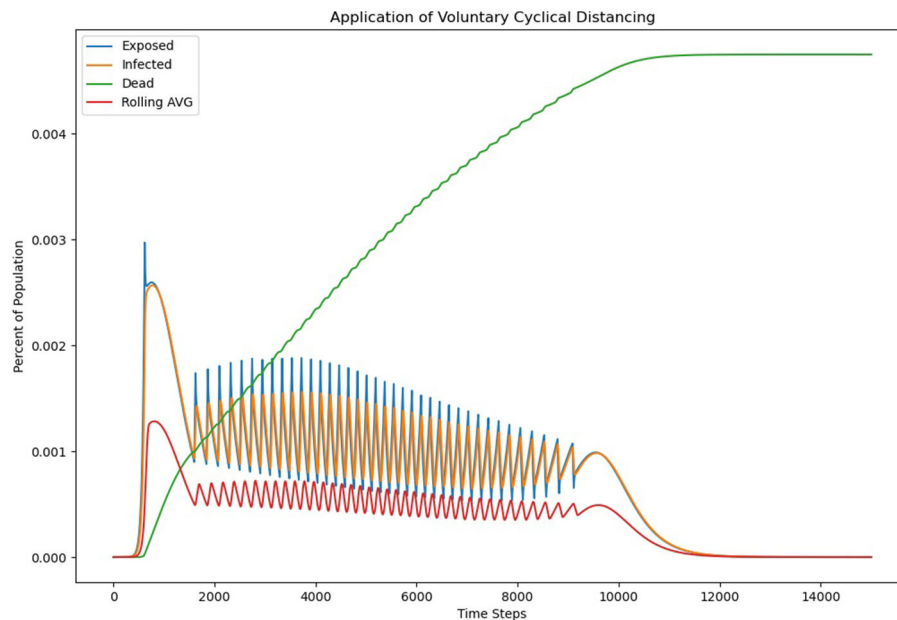
FIGURE 3 | Application of voluntary cyclical distancing.

infection to fully burn itself out under this scenario. However, mortality rates are also much lower under this scenario, with the final mortality rate coming in at roughly 0.0047 or 470 per 100,000 people. In this model, there was no fixed time at which social distancing was expected to start. However, it took roughly 62 days for the infectious load to build enough to trigger the first distancing event, which is on par with the first model. All together, there were 39 periods of social distancing, with the last ending roughly 911 days after the initial infection.

4. DISCUSSION

Feasibility depends on a number of factors, including the ability to collect sufficient data to generate infectious load indices for a desired geographic scale, and the ability to actually engage in social distancing on a voluntary basis. One question is whether we can collect enough information to create such an infectious disease index. While it would take a number of years to create a robust index that can be used in general cases, there should be no issue with creating an index specific to COVID-19. While it is true that a lot of countries, especially the United States, are unable to test anywhere close to every individual, random sampling can give us a significant amount of information on infectious load. Such random sampling requires a fraction of the number of tests that are needed to identify and isolate every infection.

With random sampling, integrated with other data gathering techniques, it is possible to have a fairly reasonable understanding of the progression of this epidemic. Much of the determination of cost effectiveness and ability to report will depend on the level of

resolution we wish to have. If the goal is to have a composite state-wide infection index, fewer tests will be needed per day. Creating a county level index would be significantly more expensive.

By reporting information to the population, we can alter behavior so that voluntary social distancing can be modulated as infection dynamics change. This modulation while extending the duration of the infection, significantly flattens the curve, without mandatory stay-at-home orders. This flattening significantly extends the duration of the pandemic, but reduces the burden on the healthcare system and reduces the overall mortality rate. Additionally, given the level to which the epidemic period is lengthened, such measures would give time to produce treatments and prophylactics. Furthermore, this method of curve flattening can help avoid a severe epidemic backdraft.

For this analysis, the initial length of time to bring the infection rate below threshold, and thus end the first social distancing event was slightly >90 days, which is significantly longer than the 60 days social distancing measure used in the first simulation, but closer to the actual length of lockdowns that were implemented in many parts of the world. Regarding the model which uses a single level of social distancing for a fixed period of time, it is concerning that the optimal social distancing coefficient is 0.65, which is likely far below the current level of social distancing, caused by the forced shutdown of all "non-essential" operations. While such extreme social distancing may be useful if limited to those within the at risk group, and between low and high risk groups, it does not seem appropriate for the general population.

There are a number of assumptions about parameter estimates that were made to test these models. In particular, the mortality rates for low and high risk populations are rough estimates.

However, while they will alter the specific values in terms out fatality outcome, they should have little impact on the progression of the infection itself. Still, additional research into the case, and infection mortality rates, and greater stratification of risk levels would help give a better picture of potential outcomes and efficacy of existing and future solutions.

Improvements to this model however could be made. Additional stratification is possible, and empirical estimates of actual contact rates could be calculated with future research. Research by Chitnis et al. may be of interest, as it looks at a highly stratified population and uses empirical estimation of heterogeneous mixing between age groups (20). Guesses in this area is likely to have some effect on the optimal social distancing level. But again, it should not impact the comparison between the fixed and cyclical distancing models to any significant extent.

Moreover, real world events as lockdowns have started coming to an end have acted as an initial test for this model. As many parts of the world began to reopen, they have experienced significant rises in new cases. These epidemic backdrafts are consistent with the model presented in this paper, and predictions of such a resurgence in cases were made in the original preprint version of this article (7). Therefore, it is reasonable to say that this model has been tested.

While elements of this model are specific to SARS-CoV-2, the general dynamics would still apply to other infections. With a little bit of time and resources applied to the problem, a general reporting system for infectious disease could be implemented. This system could be used to help reduce the severity of flu seasons, and during future epidemics. Such infection weather reports, so to speak, could become part of the new normal. Moreover, this system could be especially useful if the COVID-19 epidemic enters a seasonal pattern due to limited generation of immunity, which is a concern that has been voiced (18).

Regarding the ability to actually engage in voluntary social distancing, a major concern is the ability to take off from work. If social distancing efforts needed to be extreme and extended for a long period of time, this issue would be more problematic. Given the reliance on our job, and the general inability to take off of work for extended periods of time to recover, this issue applies to situations outside of COVID-19 as well. Anyone who feels sick, especially if they have a fever, cough, or other symptoms of a potentially infectious disease, should engage in social distancing. However, financial needs often override wisdom and public safety guidelines.

However, given that simply reducing the average contact rate by 50% is enough to significantly reduce the rate of spread of the infection, a few minor decisions are all it would take. Moderately reducing frequency and lengths of outings, and being increasingly aware of one's surroundings are all it would take to significantly reduce average contact rate. It is also likely that during periods where there are reports of high levels of infectious load, employers would be more willing to let an employee stay home and or cut back services.

Given the political nature of pandemic handling, governments may be unwilling to use this proposed system as an immediate substitute for mandatory lockdowns. But there is a question of how long mandatory lockdowns can be maintained before society refuses to comply due to fatigue. Business owners that would have to permanently close if faced with another lockdown may simply refuse to shut down and comply, feeling that they have nothing to lose. Regardless, this system can be phased in over time, and can be tested in a region with currently low apparent infection levels.

Finally, research should be conducted into creating a composite index rather than trying to produce an index for a single pathogen. Analyzing the utility and efficacy of such a composite index will be far more complicated, as it would require the incorporation of numerous pathogens. However, because the public health system would not be seeking to limit a single infection but rather the bulk of infections, it might actually be easier to produce an effective index for an aggregate.

DATA AVAILABILITY STATEMENT

Publicly available datasets were analyzed in this study. This data can be found here: https://github.com/dgoldman0/socialdistancing_final.

AUTHOR CONTRIBUTIONS

The author confirms being the sole contributor of this work and has approved it for publication.

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Health-Related Quality of Life and Influencing Factors of Pediatric Medical Staff During the COVID-19 Outbreak

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Objective: To evaluate the health-related quality of life (HRQoL) status and explore its associated factors in pediatric medical staff during the COVID-19 epidemic so as to provide fundamental evidence for clinicians and administrators to formulate targeted intervention measures to improve the HRQoL and mental health status in pediatric medical staff during this, and future pandemics.

Methods: A cross-sectional study was conducted to investigate the HRQoL of pediatric medical staff. Univariable and multivariable logistic regression were used to analyze the associated factors.

Results: A total of 2,997 participants were recruited. Females scored worse than males in terms of emotional functioning (OR = 1.6, 95% CI: 1.2–2.1) and cognitive functioning (OR = 1.4, 95% CI: 1.1–1.8). The respondents aged 30–39 and 40–49 years scored worse in nearly all domains of HRQoL compared health care professionals under 30 years old. Respondents with high education had lower scores in physical functioning (OR = 1.3, 95% CI: 1.0–1.7) and emotional functioning (OR = 1.5, 95% CI: 1.2–1.9). Compared with doctors, nurses had higher scores in all domains except for summary score and worry. The respondents whose working places had not set up pediatric fever clinics and isolated observation areas independently had lower scores in all domains except for worry. The respondents who had ever treated patients with COVID-19 had lower scores in all domains.

Conclusion: During the COVID-19 outbreak, the HRQoL of pediatric medical staff decreased. The factors associated with HRQoL can be used to develop intervention to improve HRQoL in pediatric medical staff.

Keywords: COVID-19, health related quality of life, pediatrics medical staff, mental health, intervention measures

INTRODUCTION

A Public Health Emergency concerning the novel Coronavirus (COVID-19) was issued in Wuhan, China on 31 December 2019 (1). The virus quickly spread in other regions in China and the epidemic has broken out in other countries at the same time. Confirmed patients have been found in 94 countries outside of China and more than 100,000 people have been infected globally (80,859

in China) by 7 March 2020 (2, 3). Since the outbreak of the pandemic, significant numbers of medical staff have been regularly required to work long shifts. These medical staff not only undertake high-intensity work, but also face the risk of infection. According to published literature, the outbreak of COVID-19 has caused mental health problems among medical staff and the general public worldwide (4–7). To improve the mental health of residents in China during this crisis, the Chinese National Health Commission has released guidelines for local authorities to promote psychological crisis intervention for patients, medical personnel and the public during the COVID-19 outbreak (8).

COVID-19 is primarily transmitted *via* respiratory droplets and contact. Fever and respiratory symptoms are two of the most significant clinical manifestations (9). According to published studies, pediatric outpatients (73.11%) and hospitalized patients (33.09%) are most likely to suffer from respiratory disease as compared with other types of illnesses (10). While the pediatric medical staff were at high risk of infection, their workload was also increased tremendously due to the additional safety protocols to minimize COVID-19 transmission within the pediatric wards (11–14). Additionally, since parents were not allowed into the wards due to COVID-19 restrictions, pediatric medical staff often faced higher professional pressure on a daily basis as a result of close parental oversight and had to take on additional roles as parental figures to care for the needs of the young patients (15–17). These considerations together may have an impact on health-related quality of life (HRQoL) of pediatric medical staff (18).

Therefore, in this study we aim to evaluate the HRQoL and the unique influencing factors associated with the HRQoL of pediatric medical staff during the COVID-19 pandemic. Additionally, we wanted to examine if pediatric medical staff of different demographics and working conditions were differentially impacted by the increased demands of the pandemic. This study provides fundamental evidence for clinicians and administrators to formulate targeted intervention measures to improve the HRQoL and mental health status in pediatric medical staff during this and future pandemics.

MATERIALS AND METHODS

Design and Participants

This study featured a cross-sectional design based on an online survey on Questionnaire Star between 13 and 17 February 2020 disseminated via WeChat, which is the most widely used social media platform in China as face-to-face interviews could not be carried out during the outbreak. Participants were encouraged to forward the questionnaire to other pediatric medical staff. A total of 2,997 pediatric medical staff from 29 provinces in China were recruited, and participants filled out the questionnaire anonymously, voluntarily and independently. This study was approved by the ethical board of the Fourth Military Medical University and all participants provided written informed consent.

Instrument

Data was collected *via* a self-administered online questionnaire. The first Section was related to the participants' socio-demographic characteristics, including age, gender, occupation, education, major, professional titles, hospital grade, hospital type, province, and place of residence. The second Section was related to COVID-19 protection, including whether the pediatric fever clinic and isolation observation area are set up independently, whether they have ever treated COVID-19 or suspected COVID-19 patients, whether their family or colleagues have COVID-19 or suspected COVID-19, whether their family or colleagues have come into contact with COVID-19 patients or suspected patients, and whether they have worked in the clinical field of infectious diseases. The third Section was related to HRQoL. Since the purpose of this study is to analyze the individual's HRQoL, after discussion with 5 experts, four sub-scales, including physical functioning(6 items), emotional functioning(5 items), social functioning (4 items), and cognitive functioning(5 items) were selected from the PedsQL^{TM} Family Impact Module scale (19) and considered in the questionnaire. In addition, considering the worry and panic that may be caused by the pandemic, we have included 4 items to evaluate worry status through expert discussion, resulting in a HRQoL scale featuring 5 sub-scales.

Each item of the HRQoL scale has 5-Likert response options: 0 (never a problem), 1 (almost never a problem), 2 (sometimes a problem), 3 (often a problem), and 4 (almost always a problem). The item is then linearly converted to a score of 100 (0 = 100, 1 = 75, 2 = 50, 3 = 25, 4 = 0), and the score of each subscale is the sum score of its items divided by the number of items. Therefore, the higher the score, the better the HRQoL (i.e., less negative impact) (20).

The Cronbach's α coefficient and Split-Half Coefficient were used to assess the reliability of the third Section of the questionnaire. The Cronbach's α coefficient and Split-Half Coefficient of the HRQoL scale and all its subscales were all above 0.70.

Statistical Analysis

Continuous variables were presented as Mean $\pm$ standard deviation (*mean $\pm$ sd*). Categorical variables were presented as frequencies and percentages [n (%)]. One-way analysis of variance (ANOVA) or *t*-test were used to compare scores among groups defined by each characteristic. Multiple forward stepwise logistic regression analyses (Entry = 0.05, Removal = 0.1) were used to explore the factors associated with HRQoL. In a previous study reported by Lee et al. ~27% of health care workers reported psychiatric symptoms during the 2003 SARS-CoV outbreak in Singapore (21, 22). As such, the dependent variables were the summary of HRQoL values and all their domains were converted into dichotomous variables ($\leq P_{25}$ = 1, $> P_{25}$ = 0) to better categorize participants for logistic regression analysis, according to its 25th percentile of the score, where participants below the 25th percentile were the more severely impacted group The independent variables were the demographic characteristics and COVID-19 protection-related characteristics. Statistical significance was set at $p < 0.05$. SPSS

23.0 software package for Windows was used to carry out all analyses.

RESULTS

Demographic Characteristics and HRQoL

A total of 2,970 respondents correctly filled and submitted the questionnaires out of a total of 2,997 respondents, and the effective rate of questionnaire collection was 99.1%. The respondents represented 29 provinces, among which Shaanxi province accounted for 43.3% of the responses. The vast majority of the respondents (88.8%) were women and most (43.0%) were aged 30–39 years. 52.4% of subjects were doctors. The mean score of the Summary HRQoL were 69.7 ± 15.9, and the mean scores of its five subscales were 58.9 ± 19.0 for worry, 70.5 ± 19.1 for physical functioning, 71.1 ± 20.2 for emotional functioning, 71.5 ± 19.5 for cognitive functioning and 75.5 ± 18 for social functioning. Further details of the participants' characteristics can be found in **Table 1**.

Table 1 presents the univariate analyses results. Male respondents have higher scores than female respondents in emotional functioning but lower scores than female respondents in social functioning (72.5 vs. 75.9). The respondents under 30 years old had the highest scores in all HRQoL domains, while respondents aged 40–49 years old had the lowest scores. Respondents with higher education (Masters and above) had lower scores than those with lower education (Bachelors and below) in all domains. Along the same vein, doctors had lower scores in all domains except for worry when compared to nurses. Interestingly, respondents working in the tertiary class-A hospital had higher scores in social functioning and lower scores in worry compared to respondents working in second-class hospitals. Given that Hubei is the epicenter of the pandemic, respondents from the province had overall lower scores across all domains compared to respondents from other provinces.

COVID-19 Protection Related Characteristics and HRQoL

As shown in **Table 2**, the hospitals in which 68.1% of the respondents worked had independent pediatric fever clinics and isolated observation areas. Notably, univariate analyses found that the respondents whose working places had not set up independent pediatric fever clinics and isolated observation areas had lower HRQoL scores, except for worry. The respondents who had treated patients with COVID-19 or suspected COVID-19 expectedly had lower scores than those who had not. The respondents whose family members or colleagues had ever suffered from COVID-19 or suspected COVID-19 had lower HRQoL than those who did not. The respondents whose family members or colleagues had ever contact with COVID-19 patients or suspected patients had lower scores in all domains. The respondents who had ever worked in the clinical field of infectious diseases had lower scores in all domains except for worry.

Factors Associated With HRQoL

As shown in **Table 3**, logistic regression analysis shows that females had lower emotional functioning scores (OR = 1.6, 95% CI: 1.2–2.1) and cognitive functioning scores (OR = 1.4, 95% CI: 1.1–1.8) when compared to males. In comparison to respondents below the age of 30, respondents aged 30–39 and 40–49 years had lower scores in all domains, except for worry. We also observed education level to be a factor that influenced HRQoL, where respondents with higher education level (Masters and above) had lower summary (OR = 1.5, 95% CI: 1.2–1.9), physical (OR = 1.3, 95% CI: 1.0–1.7) and emotional functioning (OR = 1.5, 95% CI: 1.2–1.9) scores compared to those with lower education level (bachelor and below). Nurses had higher scores in all domains, except for the summary score and worry, compared to doctors. Respondents living in Hubei Province had lower scores across all domains, except physical functioning, in comparison to those living in other Provinces. However, there was no statistical difference among respondents of different professional titles, hospital grade, hospital type, pediatrics major, and place of residence.

Hospital environment was a factor that influenced HRQoL as well, where respondents whose workplace had no independent pediatric fever clinics and isolated observation areas had lower scores in all HRQoL domains than those who had, except for worry. As there is higher risk of infection, the respondents who had treated patients with COVID-19 or suspected COVID-19 had lower scores in all HRQoL domains than those had not treated patients with COVID-19 or suspected COVID-19. Similarly, the respondents whose family members or colleagues had ever suffered from COVID-19 or suspected COVID-19 had lower physical functioning scores (OR = 1.8, 95% CI: 1.2–2.6) than those whose family members or colleagues had not suffered from COVID-19 or suspected COVID-19. The same was found with social functional scores where those in contact with actual or suspected COVID-19 colleagues or family had lower scores (OR = 1.3, 95% CI: 1.0–1.6) than those did not. However, prior experience working in infectious disease departments has no effect on the outcome.

DISCUSSION

In a pandemic, health care workers face greater risk of infection and undertake higher work intensity as compared with the general population. This can lead to excessive fatigue and tension which led to anxiety, sadness, grievance, helplessness, and depression, among other emotions [23]. A common thread across the different demographics and environmental situations is worry. Our results showed 8.2% of the respondents frequently felt anxious, and this is similar to the findings from Liu et al. [24]. In addition, pediatric medical staff workers may face additional pressure as they have to take over the role of parents who were not able to freely visit and care for their children due to the restrictions placed by the pandemic. This could contribute to additional emotional and physical burden on these specific groups of medical staff [15–17].

TABLE 1 | HRQoL based on socio-demographic characteristics (mean ± sd).

	N (%)	Physical functioning	Emotional functioning	Social functioning	Cognitive functioning	Worry	Summary score
Gender							
Male	334 (11.2)	69.2 ± 19.2	73.2 ± 20.3	72.5 ± 18.9	70.5 ± 19.8	59.9 ± 19.8	69.3 ± 16.7
Female	2,636 (88.8)	70.6 ± 19.1	70.9 ± 20.2	75.9 ± 17.8	71.6 ± 19.5	58.7 ± 18.9	69.8 ± 15.8
P-value		0.193	0.046	0.001	0.324	0.269	0.601
Age (years)							
<30	805 (27.1)	74.9 ± 18.2	75.4 ± 19.9	79.5 ± 17.3	77.1 ± 19.1	59.9 ± 20.1	73.7 ± 15.6
30–39	1,277 (43.0)	69.3 ± 19.1	70.4 ± 20.5	75.2 ± 17.9	71.1 ± 19.6	57.8 ± 18.9	69.0 ± 16.0
40–49	541 (18.2)	66.8 ± 18.8	68.2 ± 19.0	71.7 ± 18.2	65.4 ± 18.0	58.3 ± 18.2	66.2 ± 15.0
≥50	347 (11.7)	69.9 ± 19.7	68.5 ± 19.8	73.6 ± 17.7	69.5 ± 19.0	61.3 ± 17.5	68.7 ± 15.7
P-value		<0.001	<0.001	<0.001	<0.001	0.006	<0.001
Education							
Bachelor and below	2,540 (85.5)	71.2 ± 18.9	72.3 ± 20.1	76.4 ± 17.7	72.4 ± 19.4	59.5 ± 19.0	70.6 ± 15.7
Master and above	430 (14.5)	66.1 ± 19.3	64.5 ± 19.6	70.4 ± 18.7	66.5 ± 19.4	54.9 ± 18.3	64.7 ± 15.9
P-value		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Occupation							
Doctors	1,557 (52.4)	67.7 ± 18.9	68.4 ± 19.8	72.1 ± 18.1	68.0 ± 19.1	58.6 ± 17.7	67.1 ± 15.4
Nurses	1,413 (47.6)	73.5 ± 18.9	74.2 ± 20.2	79.3 ± 17.1	75.4 ± 19.2	59.2 ± 20.3	72.6 ± 15.9
P-value		<0.001	<0.001	<0.001	<0.001	0.390	<0.001
Professional titles							
Senior	747 (25.2)	67.5 ± 19.3	68.3 ± 19.8	71.8 ± 17.9	67.1 ± 18.2	59.4 ± 17.6	67.0 ± 15.4
Intermediate	883 (29.7)	69.0 ± 19.3	69.3 ± 19.9	74.5 ± 18.1	69.4 ± 19.8	57.8 ± 19.2	68.2 ± 15.9
Junior	1,340 (45.1)	73.1 ± 18.5	73.9 ± 20.2	78.3 ± 17.5	75.3 ± 19.3	59.2 ± 19.5	72.3 ± 15.8
P-value		<0.001	<0.001	<0.001	<0.001	0.122	<0.001
Hospital grade							
Tertiary class-A hospital	2,172 (73.1)	70.6 ± 19.3	71.0 ± 20.5	75.9 ± 18.0	72.2 ± 19.5	58.2 ± 19.3	69.8 ± 16.1
Second class hospital	798 (26.9)	69.9 ± 18.6	71.4 ± 19.3	74.5 ± 18.0	69.8 ± 19.4	60.7 ± 18.1	69.4 ± 15.4
P-value		0.372	0.655	0.065	0.003	0.001	0.540
Hospital type							
Comprehensive hospital	2,224 (74.9)	70.6 ± 19.4	71.6 ± 20.1	75.7 ± 18.0	71.5 ± 19.6	59.4 ± 19.1	70.0 ± 16
Specialized hospital	746 (25.1)	70.0 ± 18.3	69.8 ± 20.4	75.0 ± 18.1	71.5 ± 19.3	57.1 ± 18.4	69 ± 15.7
P-value		0.475	0.033	0.354	0.956	0.004	0.124
Pediatrics major							
Internal medicine	1,836 (61.8)	70.4 ± 19.1	70.9 ± 19.9	74.9 ± 17.9	71.2 ± 19.4	59.2 ± 19.1	69.6 ± 15.8
Respiratory	193 (6.5)	71.0 ± 19.4	72.6 ± 22.5	76.1 ± 18.4	72.0 ± 18.6	58.1 ± 20.7	70.2 ± 16.8
Infection	79 (2.7)	71.6 ± 19.0	74.8 ± 20.8	77.0 ± 17.6	74.2 ± 21.4	60.4 ± 17.4	71.8 ± 15.7
Critical medicine	274 (9.2)	69.5 ± 20.0	71.6 ± 19.9	76.8 ± 17.7	73.6 ± 20.3	58.6 ± 18.8	70.2 ± 16.2
Others	588 (19.8)	70.6 ± 18.7	70.7 ± 20.2	76.5 ± 18.2	70.9 ± 19.5	58.0 ± 18.3	69.6 ± 15.6
P-value		0.879	0.375	0.196	0.214	0.615	0.726
Place of residence							
City	2730 (91.9)	70.5 ± 19.2	71.1 ± 20.2	75.5 ± 18.0	71.6 ± 19.4	58.9 ± 18.9	69.8 ± 15.9
Rural	240 (8.1)	70.1 ± 18.2	71.3 ± 19.7	75.6 ± 17.6	70.8 ± 20.2	58.5 ± 19.6	69.5 ± 15.7
P-value		0.788	0.932	0.955	0.561	0.739	0.793
Province							
Hubei	83 (2.8)	63.6 ± 15.9	56.8 ± 18.3	67 ± 16.9	63.8 ± 16.6	41.0 ± 15.0	59.0 ± 12.2
Others	2,887 (97.2)	70.7 ± 19.1	71.6 ± 20.1	75.8 ± 18	71.7 ± 19.5	59.4 ± 18.8	70.0 ± 15.9
P-value		0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Total	2,970 (100.0)	70.5 ± 19.1	71.1 ± 20.2	75.5 ± 18	71.5 ± 19.5	58.9 ± 19.0	69.7 ± 15.9

TABLE 2 | HRQoL based on COVID-19 protection related characteristics ($\bar{x} \pm s$).

	N (%)	Physical functioning	Emotional functioning	Social functioning	Cognitive functioning	Worry	Summary score
The pediatric fever clinic and the isolated observation set up independently							
No	946 (31.9)	68.1 ± 19.7	69.3 ± 20.1	73.0 ± 18.3	67.6 ± 19.5	58.0 ± 18.3	67.4 ± 16.0
Yes	2,024 (68.1)	71.6 ± 18.7	72.0 ± 20.1	76.7 ± 17.7	73.4 ± 19.2	59.3 ± 19.3	70.8 ± 15.7
P-value		<0.001	0.001	<0.001	<0.001	0.077	<0.001
Whether you have ever treated patients with COVID-19 or suspected COVID-19							
No	2,484 (83.6)	71.5 ± 19.1	72.2 ± 20.0	76.5 ± 17.8	72.4 ± 19.3	60.0 ± 18.9	70.7 ± 15.7
Yes	486 (16.4)	65.2 ± 18.4	65.7 ± 20.2	70.7 ± 18.4	67.0 ± 19.7	53.2 ± 18.5	64.6 ± 15.7
P-value		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Whether your family or colleagues have ever suffered from COVID-19 or suspected COVID-19							
No	118 (4.0)	64.5 ± 18.2	64.4 ± 21.8	70.5 ± 18.2	66.7 ± 18.4	51.8 ± 18.8	63.8 ± 15.3
Yes	2,852 (96.0)	70.7 ± 19.1	71.4 ± 20.1	75.7 ± 17.9	71.7 ± 19.5	59.1 ± 18.9	70.0 ± 15.9
P-value		0.001	<0.001	0.002	0.006	<0.001	<0.001
Whether your family or colleagues have ever contact with COVID-19 patients or suspected COVID-19							
Yes	364 (12.3)	65.8 ± 17.2	65.3 ± 19.5	70.1 ± 17.8	67.0 ± 17.5	53.1 ± 17.6	64.6 ± 14.4
No	2606(87.7)	71.1 ± 19.2	72.0 ± 20.1	76.3 ± 17.9	72.2 ± 19.7	59.7 ± 19	70.5 ± 16.0
P-value		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Whether you have ever worked in the clinical field of infectious diseases							
No	2,362 (79.5)	71.1 ± 19.0	71.8 ± 20.1	76.2 ± 17.9	72.3 ± 19.5	59.0 ± 19.1	70.3 ± 15.8
Yes	608 (20.5)	67.9 ± 19.3	68.7 ± 20.5	72.8 ± 18.2	68.4 ± 19.4	58.3 ± 18.5	67.4 ± 16.0
P-value		<0.001	0.001	<0.001	<0.001	0.381	<0.001
Total	2,970	70.5 ± 19.1	71.1 ± 20.2	75.5 ± 18.0	71.5 ± 19.5	58.9 ± 19.0	69.7 ± 15.9

TABLE 3 | Logistic regression analysis of HRQoL.

	Physical functioning	Emotional functioning	Social functioning	Cognitive functioning	Worry	Summary score
Gender (ref = Male)						
Female	–	1.6 (1.2–2.1)	–	1.4* (1.1–1.8)		
Age (ref = "<30")						
30–39	1.6** (1.3–2.0)	1.6** (1.3–2.0)	1.3* (1.1–1.7)	1.6** (1.3–2.1)	1.1 (0.9–1.4)	1.8** (1.4–2.2)
40–49	1.6* (1.2–2.1)	1.7** (1.3–2.2)	1.4* (1.1–1.9)	2.0** (1.6–2.8)	0.9 (0.8–1.2)	2.0** (1.5–2.6)
≥50	1.3 (0.9–1.8)	1.3 (0.9–1.8)	1.1 (0.8–1.5)	1.5* (1.1–2.1)	0.7* (0.5–0.9)	1.3 (0.9–1.8)
Education (ref = "Bachelor and below")						
Master and above	1.3* (1.0–1.7)	1.5* (1.2–1.9)	–	–		1.5** (1.2–1.9)
Occupation (ref = "Doctors")						
Nurses	0.8* (0.6–0.9)	0.8* (0.7–0.99)	0.6** (0.5–0.7)	0.7* (0.6–0.9)		
Province (ref = "out of Hubei")						
Hubei	–	2.2* (1.4–3.5)	1.8* (1.1–2.9)	1.6* (1.0–2.6)	6.3** (3.4–11.5)	2.2* (1.4–3.6)
Whether the pediatric fever clinic and the isolated observation area are set up independently (ref = "Yes")						
NO	1.3* (1.03–1.5)	1.2* (1.01–1.4)	1.2* (1.03–1.5)	1.6* (1.3–1.9)		1.5** (1.3–1.8)
Whether you have ever treated patients with COVID–19 or suspected COVID–19 (ref = "No")						
Yes	1.3** (1.1–1.7)	1.6** (1.3–1.9)	1.5* (1.2–1.8)	1.4* (1.2–1.8)	1.6** (1.3–2.0)	1.7**(1.4–2.1)
Whether your family or colleagues have ever suffered from COVID-19 or suspected COVID-19 (ref = "No")						
Yes	1.8* (1.2–2.6)	–	–	–	–	
Whether your family or colleagues have ever contact with COVID-19 patients or suspected patients (ref = "No")						
Yes	–	–	1.3* (1.0–1.6)	–	–	

*indicates that the p value is less than 0.05. **indicates that the p value is less than 0.001.*

Multivariate analysis showed that the socio-demographic characteristics associated with HRQoL of the respondents were gender, age, occupation and education. Females were associated with worse scoring than males in emotional functioning and cognitive functioning. Expectedly, the HRQoL of respondents living in Hubei Province was worse, which may be related to the more serious epidemic situation and higher risk of infection. We speculate that the HRQoL of doctors was worse than that of nurses because doctors receive patients first, and they need to conduct physical patient examinations (e.g., pharynx examinations), leading to a relatively higher risk of infection than nurse. In addition, doctors play vital roles in diagnosis and treatment planning. These roles require more effort in making decisions during treatment of patients and evaluating their recovery trajectory, experiencing more stress compared with nurses (25). Communication breakdowns between doctors and nurses working in neonatal wards have also been previously reported, and this could lead to considerable amount of emotional stress for doctors. A path to improve functioning of doctors within the wards could involve better communication between doctors and nurses, as well as reorganizing work schedules to allow more rest time between shifts (26). It is also important to foster trust and good relationships between the medical staff team within the wards (27).

Multivariate analysis also showed that HRQoL was closely related to COVID-19 protection-related characteristics, especially establishment of independent settings for the fever clinic and isolation area, as well as the treatment of patients with COVID-19 or suspected COVID-19. We hypothesize that these two factors were closely related to the risk of infection. The higher the possibility of infection, the more likely professionals are to suffer from anxiety (28). According to the joint investigation report from the China-World Health Organization and the relevant data released by the Chinese government, nosocomial infections among medical staff largely occurred in the early stage of COVID-19 infection, primarily in Wuhan when there was a lack of materials and experience in dealing with the disease (29). These findings suggest that it is critical to strengthen the safety of health care workers. Measures should be taken to reduce the risk of nosocomial infection, such as triage outside of hospitals (e.g., in tents or other shelters), establishment of an independent fever clinic and isolation area, and an adequate supply of protective equipment (30).

After the outbreak of the epidemic, the National Health Commission of China issued the guideline for emergency psychological crisis intervention during the outbreak of COVID-19 on January 26, 2020 (31). This guideline has formulated psychological intervention programs and key points for different personnel, such as people infected with COVID-19, personnel under quarantine, front-line staff, and the general public. According to our results, we believe that in addition to adopting the guidelines for daily psychological crisis intervention, we should also consider more targeted interventions according to the characteristics of pediatric medical staff to allay their concerns and improve their HRQoL. Pediatric medical staff who are 30–49 years old, of higher academic qualifications, doctors, and have a higher risk of infection should be given more attention. If

the conditions permit, measures could be taken to meet their personal needs, such as care of an older family member and providing front-line staff with accommodations near the hospital. This would help maintain individual and team performance over the long run and improve the mental and physical health of these health care professionals. This is especially applicable for pediatric medical staff who have had contact with COVID-19 patients and suspected cases within their own family, as they face higher risks of infection as well as the additional emotional burden because of the health condition of their kin.

There are some limitations in this study. First, since this study is a cross-sectional survey it is not possible to elucidate causal relationships (7). Second, the survey was conducted online, which may result in respondent bias. However, face-to-face surveys were not possible during the pandemic. Finally, as we collected data from only medical staff working in pediatric wards, we are not able to generalize the findings of this study to other wards and medical staff workers.

CONCLUSION

During the outbreak of COVID-19, the HRQoL of pediatric medical staff was impacted. The respondents with different demographic characteristics and COVID-19 protection-related characteristics were impacted to varying degrees. Therefore, clinicians and administrators should focus on developing interventions according to the characteristics of different groups to improve the HRQoL of medical staff.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by ethical board of the Fourth Military Medical University. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

All authors on this manuscript made significant contributions to the study design. XJ and LS have made substantial contributions to design of the work. FH and ZY were responsible for the data analysis and interpretation of data, as well as drafting the manuscript. YW, WZ, YL, and L-cZ were involved in the acquisition of data. All authors read and approved the final manuscript.

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Childhood Immunization and COVID-19: An Early Narrative Review

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The COVID-19 pandemic has evolved into arguably the largest global public health crisis in recent history—especially in the absence of a safe and effective vaccine or an effective anti-viral treatment. As reported, the virus seems to less commonly infect children and causing less severe symptoms among infected children. This narrative review provides an inclusive view of scientific hypotheses, logical derivation, and early analyses that substantiate or refute such conjectures. At the completion of a relatively less restrictive search of this evolving topic, 13 articles—all published in 2020, were included in this early narrative review. Directional themes arising from the identified literature imply the potential relationship between childhood vaccination and COVID-19—either based on the potential genomic and immunological protective effects of heterologous immunity, or based on observational associations of cross-immunity among vaccines and other prior endemic diseases. Our review suggests that immune response to the SARS-CoV-2 virus in children is different than in adults, resulting in differences in the levels of severity of symptoms and outcomes of the disease in different age groups. Further clinical investigations are warranted of at least three childhood vaccines: BCG, MMR, and HEP-A for their potential protective role against the SARS-CoV-2 virus.

Keywords: children, vaccines, COVID-19, SARS-CoV-2, immunization

INTRODUCTION

The novel Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) has infected close to 9.5 million people and has claimed nearly 762,000 lives globally, as of August 16, 2020 (1). This pandemic has evolved into arguably the largest global public health crisis in recent history—especially in the absence of a safe and effective vaccine or an effective anti-viral treatment. This virus has demonstrated a high attack rate, a broad gamut of identifiable symptoms, and viability among a potentially massive number of infected silent carriers.

Unlike many infectious diseases, such as endemic malaria and common flu where children are known to have the highest mortality rates and to drive transmission in households and communities—it appears as it could be that SARS-CoV-2 just does not translate into severe disease as frequently in children, specifically for young children, below 10 years of age. Moreover, infected children suffer milder symptoms of COVID-19, with much lower case-fatality rates (CFR), and recover quickly from the infection (2–7). In an initial assessment from Wuhan, China, among 50 children identified with COVID-19, the severity varied between asymptomatic and mild in 96% of the patients (8). While diagnostic findings were similar to those of adults, fewer children developed severe pneumonia. Neonates, on the other hand, have developed symptomatic and more severe COVID-19 (2, 7).

Data obtained from the Chinese Center for Disease Control and Prevention as of February 17, Spanish Ministry of Health as of March 24, Korea's Centers for Disease Control and Prevention as of March 24, and the Italian National Institute of Health as of March 17—suggests that the CFR for COVID-19 for children are disproportionately lower compared to any other age group (9). The CFR was 0% for all four countries for the age group "0–9 years." Singh et al., suggest that milder symptomatology implies potential immunologic protective factors in children and the direction for a design of interventions for all age groups (2). While it is likely that early publication of reports from countries with generally more equipped healthcare systems may not be fully indicative of the long-term overall potential impact in less developed nations—current observations do not suggest such trends yet.

Propositions for such lower observed rate of fatality and symptomatic illness have included the potential protective effect of global active viral immunization of children from birth till 6 years of age (10). It is suggested that childhood vaccines for mumps, rubella, poliomyelitis, Hepatitis B, and varicella may impart transient immunity against SARS-CoV-2 that protects their lung cells from contracting COVID-19 (10). Subsequently, aging, immunosuppression, and co-morbid states reduce the adaptability of the immune system (5).

The rates of heterologous immunity have been studied in some of the common childhood vaccinations including measles and Bacillus Calmette-Guerin (BCG) vaccines. African American girls who received the measles vaccine demonstrated 47% reduced mortality from other diseases. Similarly, the BCG vaccine has demonstrated a 25% reduction in mortality to other diseases (11). Previous research has supported that live vaccines have increased resistance to other vaccine unrelated diseases. Thus, they have specific effects by preventing the targeted disease but also non-specific effects on non-targeted infections as well. It is theorized that vaccines boost immune responses, offering additional resistance to viruses other than the ones they are intended to prevent (12). It should also be noted that research only suggests there is a correlation between vaccines and non-specific responses, not causation.

Such hypothesis of cross-immunogenicity of existing childhood vaccines with the novel coronavirus, if proven true, could have far reaching implications for public health immunization policies across the globe. However, no broad assessment of this topic has thus far been undertaken to the best of our knowledge at the time of this writing.

In this narrative review, we provide an inclusive view of scientific hypotheses, logical derivation, and early analyses that substantiate or refute such conjectures. The goal of this study is not to establish a comprehensive, systematic understanding of the link between childhood vaccination and COVID-19 outcomes. Instead we attempt to offer a robust starting point to facilitate further development of relevant hypotheses and designing of studies to test this promising public health opportunity.

METHODS

Given the early stage in the evolving literature on this topic, our attempt at a systematic search of health sciences databases such as PubMed using keywords and search strategies such as: "coronavirus OR COVID-19 OR nCoV OR SARS-CoV-2) AND (child OR children OR childhood OR pediatric OR infant OR babies OR baby OR neonates) AND (immunization OR vaccination OR vaccine)" limited to English language articles published in between June 2019 and April 2020 did not yield sufficiently relevant publications. While there may have been articles that were published in other languages during the review period, those were not included unless an English translation was available. Given the importance of this topic, we believe that such non-English articles, if any, will be included in future assessments as there is broader presence of the data in global literature.

As such, given the broader base of sources accessed by its search function, we performed a plain language search using the same keywords listed above on Google Scholar, which includes journal and conference papers, theses and dissertations, academic books, pre-prints, abstracts, technical reports, and other scholarly literature from all broad areas of research (13). All types of study and countries of origin were eligible for inclusion. In addition, any relevant articles that were identified during and outside the formal search process were also included if their content were relevant to our study. Four reviewers extracted relevant data into a cloud-based spreadsheet. We recorded the country of origin, study design, type of data, results, and conclusions. As this was intended to be a rapid review, each article was reviewed by one reviewer.

RESULTS

At the completion of the quick search and identification process, 14 out of 30 identified articles were included in this early narrative review (**Table 1**). Included papers were all published in 2020 following the early release of data on COVID-19, presenting hypotheses about the potential relationship between childhood vaccination and COVID-19—either based on the protective effects of heterologous immunity, or based on observational associations of cross-immunity among vaccines and other prior endemic diseases.

The Immunological Basis for Potential Effect of Childhood Vaccines in Disease Expression

In many countries, children are routinely vaccinated against a number of bacterial and viral diseases. Vaccines may have non-specific physiologic effects when they alter the immune response to unrelated organisms, called heterologous immunity. The non-specific effects of vaccines are usually more pronounced in girls and appear to be maximal in the first 6 months of life (11)—when passed maternal immunity is further supplemented by newly introduced vaccines, starting at 2 months. There are several theories as to why heterologous immunity may occur.

Theme	References#	Authors	Country of origin of study	Type of study
Immunological basis for potential effect of childhood vaccines in disease expression	(10)	Salman S, Salem M	Egypt	Hypothesis
	(14)	O'Neill LA, Netea MG	Ireland	Hypothesis
	(15)	Sabir DK, Sidiq KR, Ali SM	Iraq	Genomic data analysis
	(16)	Abdulamir AS, Hafidh RR	Iraq	Hypothesis
The bacillus-calmette-guerin (BCG) vaccine	(17)	Miller A, Reandelar MJ, Fasciglione K, Roumenova V, Li Y, Otazu GH	Global	Regression analysis
	(18)	Shet A, Ray D, Malavige N, Santosham M, Bar-Zeev N	United States of America	Regression analysis
	(19)	Escobar LE, Molina-Cruz A, & Barillas-Mury C	Global	Regression analysis
	(20)	Escobar LE, Molina-Cruz A, & Barillas-Mury C	Global (2)	Regression analysis
	(21)	Paredes JA, Garduño V, Torres J	Mexco	Regression analysis
	(22)	Hamiel U, Kozer E, Youngster I	Israel	Regression analysis
The measles, mumps, and rubella (MMR) vaccine	(23)	Saad M & Elsalamony R	Egypt	Hypothesis
	(24)	Franklin R, Young A, Neumann B, Fernandez R, Joannides A, Reyahi A, et al.	United Kingdom	Genomic data analysis
	(25)	Fidel PL, Noverr MC	United States of America	Hypothesis
The Hepatitis-A (HEP-A) vaccine	(26)	Sarialioglu F, Apak FBB, Haberal M	Turkey	Hypothesis

Salman and Salem suggest that cross-immunogenicity of childhood vaccines for multiple viruses could potentially be a reason for the relatively milder infection and severity of COVID-19 among children (10). Most routine viral vaccines are either inactivated or killed viruses that stimulate T Helper 1 cells (CD4+) to secrete many different types of cytokines as interferon gamma, interleukin-2 (IL-2), and IL-12, improving the cytotoxicity of natural killer cells to recognize and destroy cells infected with new cross-reactive viruses. For example, warts that are caused by human papilloma virus (HPV) could be ameliorated using intralesional MMR vaccine (10).

Furthermore, neutralizing antibodies produced against the foregoing vaccine-preventable microbes might cross-react with the antigenic epitopes of the spike (S) and nucleocapsid (N) proteins and prevent COVID-19 in children (15). An investigation of this hypothesis, using the BLAST search tool, showed no significant sequence similarity between these proteins and those in the childhood vaccine-preventable microbes, inferring that memory T-cells, rather than vaccine neutralizing antibodies, may be involved in the protection of children against COVID-19 owing to them having a larger number of naive T-cells that can be programmed to protect them against the disease (27).

Potentially, the low immunity in children that doesn't exaggerate the immune response against the virus as in the case of adults, could explain the lesser severity of SARS-CoV-2 in this age group. Children have less adults-like memory cells specific to other circulating coronaviruses and therefore, are less capable to

mount a devastating and vigorous cell-mediated attack on alveoli and interstitial tissue of the lung upon new infection (16).

The Bacille Calmette–Guérin (BCG) Vaccine

The Bacille Calmette-Guérin (BCG) vaccine is given in infancy for prevention of severe forms of tuberculosis and has the widest use, and a strongest safety profile among all childhood vaccines (28). Epidemiological and randomized trial evidence suggest a protective effect of BCG on infant mortality via non-specific heterologous protection against other infections possibly through innate immune epigenetic mechanisms (29).

O'Neil and Netea suggest that induction of trained immunity by BCG vaccine could provide protection against COVID-19, and the use of oral polio vaccine and new recombinant BCG-based vaccine VPM1002 may be some of the approaches to induce resistance to SARS-CoV-2 (14). The authors hypothesize that induction of trained immunity is at least partly the mechanism through which BCG vaccination induces its beneficial effects and might protect against SARS-CoV-2.

A retrospective study compared countries that do not have BCG vaccination policies (Italy, USA, Lebanon, the Netherlands, and Belgium), to countries that have such policies (17). The results showed that while middle-high and high-income countries with current universal BCG policies had 0.78 COVID-19 deaths per million, those without such policies had 16.39 COVID-19 deaths per million people—and the difference was statistically significant. Further analysis of 28 countries found a positive significant correlation ($p = 0.02$) between the year of the universal vaccination policy and mortality rate—suggesting

that if the policy to vaccinate was adopted at an earlier year, more of the elderly population in these countries would have been vaccinated, thus potentially offering them more protection. In countries, such as Italy, where BCG vaccine was never given, the mortality rate was significantly higher compared to Japan where BCG vaccination has been implemented since 1947. In countries, such as Iran, with BCG vaccination starting in 1984, mortality was higher since today's elderly population did not receive the vaccination.

In order to mitigate the bias centered around the differential epidemic time curves experienced by different countries, Shet et al., calculated days from the 100th COVID-19-positive case to align countries on a more comparable time curve (18). A log-linear regression model was built with crude COVID-19-attributable mortality data per 1 million population for each country as outcome, BCG vaccine inclusion in the national immunization schedule as exposure, and adjusted for the effects of: country-specific GDP per capita, the percentage of population 65 years and above, and the relative position of each country on the epidemic timeline. COVID-19-attributable mortality among BCG-using countries was 5.8 times lower ($P = 0.006$) than in non-BCG-using countries. Sensitivity analysis run excluding China as the majority case contributor from the model resulted in no appreciable change in the protective effect of BCG.

Escobar et al., in a study that carefully controlled for confounding variables found that there was an inverse correlation between countries/locations with a stronger BCG vaccination policy and COVID-19 related mortality (19). COVID-19 mortality rates in New York, Illinois, Alabama and Florida—states without BCG-vaccination policies in the US, were significantly higher than locations with BCG-vaccine policies, namely Pernambuco, Rio de Janeiro, and Sao Paulo in Brazil, or Mexico State and Mexico City in Mexico.

In a more recent study, the same authors demonstrate a strong correlation between the BCG index and COVID-19 mortality in different socially similar European countries ($r^2 = 0.88$; $P = 8 \times 10^{-7}$), indicating that every 10% increase in the BCG index was associated with a 10.4% reduction in COVID-19 mortality (20).

However, evidence suggesting a protective effect of the BCG vaccine was not found to be universally consistent and only demonstrated association not causality. There indeed are a myriad of factors apart from the effect of a childhood vaccine that could impact the findings of association, and such caution in interpretation would be recommended—especially this early in our understanding of the COVID-19 disease.

Paredes et al., showed that when confounders such as under-reporting, SARS-CoV-2 capability testing and differing lockdown measures were considered, the differential impact of BCG vaccination on COVID-19 related mortality rate was not significant (21). Among high-income countries, the mean number of deaths per 1 million population for countries with no universal BCG vaccination (223.2 ± 166.1) was not statistically significant from countries with current or previous BCG vaccination programs (55 ± 82.5; $P = 0.85$). No statistically significant difference was noted in mean number of deaths at the 1,000th case in these three groups either.

Hamiel et al., compared infection rates and proportions with severe COVID-19 disease in 2 cohorts: individuals born during 3 years before and 3 years after cessation of the universal BCG vaccine program in Israel (22). There was no statistically significant difference in the proportion of positive reverse transcriptase-polymerase chain reaction tests for SARS-CoV-2 in the BCG vaccinated group compared to the unvaccinated group (11.7 vs. 10.4%, $p = 0.09$). There also was no statistically significant difference in positivity rates per 100,000 (121 vs. 100, $p = 0.15$).

The Measles, Mumps, and Rubella (MMR) Vaccine

Saad at al., suggested two potential mechanisms for higher COVID-19 cases per population ratio and higher death rate in Italy (no MMR vaccine) compared to China: (1) by generating bystander immunity the measles vaccine increases ability of immune system to combat non-measles pathogens, including coronaviruses, and (2) due to shared structural similarities between measles and coronavirus the cross-reactivity and immunity between the measles vaccine and coronavirus leads to partial protection against COVID-19 (23).

Franklin et al., identified that the macro domains of SARS-CoV-2 and rubella virus and the MMR vaccine, share 29% amino acid sequence identity (24). This finding suggests the viruses possess the same protein fold. Patients with high illness severity had high levels of rubella IgG (161.9 + 147.6 IU/ml) compared to patients with a moderate severity of disease (74.5 + 57.7 IU/ml). The authors suggest the MMR vaccine could result in potentially reduced severe outcomes with COVID-19.

In their commentary, Fidel and Noverr support the use of live attenuated MMR vaccine as a preventive measure against the pathological inflammation and sepsis associated with COVID-19 infection (25). While they emphasize the strictly preventive nature of the suggestion, the basis of such suggestion is the induction of non-specific effects by live attenuated vaccines that represent "trained innate immunity" delivered by leukocyte precursors in the bone marrow more effectively functioning against broader infectious attacks. On the basis of data from prior BCG trials in infants, the vaccine-induced trained innate cells are expected to remain in the circulation for roughly 1 year, which should see people through the most severe waves of COVID-19 infection.

The Hepatitis-A (HEP-A) Vaccine

Sarialioglu et al., reported on the differences in the rate in which COVID-19 had affected some countries such as China, US, Italy, Spain, France, England, the Netherlands, and Belgium more severely than some others such as India, Pakistan, countries of the African continent, and South America which had lower rates of infection and mortality at the time of their study (26). The authors hypothesize that routine vaccination for hepatitis A virus (HAV) causing high seroprevalence among populations in countries in the low COVID-19 prevalence group, while it is rather low in the industrialized countries.

In addition, the authors point to the COVID-19 experience in the Diamond Princess cruise ship, which after arriving in

Yokohama, Japan on February 3rd 2020, was placed under quarantine for the disease based on another passenger who had disembarked in Hong Kong a couple of days earlier and has tested positive for the virus (30). A report (31) showed that by February 20th over 18% of the 700 infected among the 3,700 people showed no symptoms. The low frequency of symptomatic disease on the ship, may be explained by stimulated immunity before passengers started the cruise trip when HEP-A vaccine was recommended for international travel in areas with high HAV endemicity. However, no publicly available information on the HEP-A vaccination status of the passengers were found.

While there does not seem to be any objective evidence to support this yet, the authors further contemplate that the severity of COVID-19 and vulnerability of very young children, particularly infants <1 year of age, may be attributed to the eventual decrease of maternal anti-HAV antibodies toward age 1 year—as HEP-A vaccine is not administered until after 1 year of age.

The authors conclude that immune response caused by the hepatitis A vaccine may be protective against COVID-19 infection by a possible adaptive immune cross-reaction. Patients with asymptomatic COVID-19 disease could indirectly indicate those with protection from HAV seropositivity. The HEP-A vaccine may help to keep the COVID-19 infection at mucosal colonization levels and prevent lower respiratory tract involvement and fatality (26).

DISCUSSION

At the time of this writing, the pandemic of COVID-19 continues to be a global public health emergency, claiming the lives of hundreds, and infecting millions all over the world. While the trend thus far shows a relatively less severe morbidity and mortality profile of the disease among children, the reason behind such a trend is not yet well-understood. While several theories for such welcome relief have been proposed, we present available insights and hypotheses on the potential link between childhood vaccination and the less severe expression of COVID-19 in this early narrative review.

Although it is relatively early in the process of the scientific community's gaining full understanding of the SARS-CoV-2 virus and characterization of its infection, known virus-prevention strategies from past pandemics that could lead to potential attenuation of the currently ongoing disaster, are of high interest. Public health emergencies, by their nature, often do not have the luxury of time needed for well-researched remedies, and that is why hypotheses and theories are relevant—even if with the possibility of bridging current patients and populations to the time when treatment and vaccination for COVID-19 are available.

Our narrative review finds that there indeed is a potential scientifically-based possibility of heterologous immunity from common childhood vaccines to be imparting a protective effect on COVID-19 infections in children. While not unequivocal, population-level differences found in several studies in the rate of infection and severity of expression of COVID-19 between countries with and without certain common childhood vaccination policies suggest the need for deeper and more well-structured investigation, in the minimum. Although prevalence of some target diseases and organisms may have been eradicated in certain parts of the world, the reinstitution of relatively inexpensive vaccines for those diseases into the currently recommended childhood vaccination regimen may merit careful re-evaluation. Our review found suggestions from the medical community of such promise in at least three of the most common vaccines given to children—BCG, MMR, and HEP-A.

However, it is indeed not recommended that such practices be instituted without establishing a reasonable scientific evidence to validate some of these hypotheses—especially when children are involved. Pragmatic randomized controlled trials designed to time- and cost-efficiently test feasible primary endpoints of cross-immunogenicity with existing childhood vaccines should be initiated alongside focused global efforts to develop effective treatment for COVID-19, and a safe and effective SARS-CoV-2 vaccine. At least, rapid testing and eventual use of promising, non-COVID-19 vaccines could be explored for help with avoiding large patient casualties in the meantime, until adequate treatment and vaccines are developed.

Certainly, routine pediatric vaccination for other conditions needs to be maintained even in the face of parental fear of potential exposure to COVID-19 during well child visits. Parents need to be reminded of the increased risks for outbreaks of vaccine-preventable diseases that children and their communities may face upon lifting of social distancing guidelines—unless children are vaccinated appropriately.

CONCLUSION

Based on our review, it may be concluded that although controlled clinical trials may be time and resource intensive, those may be justifiable in investigating further and confirming the value of at least three childhood vaccines: BCG, MMR, and HEP-A as possible explanations for lower incidence of COVID-19, and less severe expression of the disease in children. Currently hypothesized explanations for an evidently less severe impact of COVID-19 on children globally includes the protective cross-immunity provided by other common childhood vaccines. There is a strong basis to hypothesize that immune response to the SARS-CoV-2 virus in children is different than in adults, resulting in differences in the levels of severity of symptoms and outcomes of the disease in different age groups.

AUTHOR CONTRIBUTIONS

Upon initial suggestion of the topic by the BB-S, JK-H, DR, and SR participated equally in generating the research question, conducting library search, and writing the manuscript and selected articles were divided equally for review and data entering into the common spread sheet. All authors participated in revising and editing the manuscript.

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Impact of the COVID-19 Pandemic on Loneliness Among Older Adults

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The COVID-19 pandemic has created a pattern of everyday physical distancing worldwide, particularly for adults aged 65+. Such distancing can evoke subjective feelings of loneliness among older adults, but how this pandemic has influenced that loneliness is not yet known. This study, therefore, explored the association between subjective loneliness and different time phases of the COVID-19 pandemic to explain the pandemic's impact on loneliness among older adults. The analysis employed a sample of 1,990 community-dwelling older adults aged 65–95 (mean age = 72.74 years; 43% female) in Switzerland. Data collection occurred both before and after Switzerland's first confirmed COVID-19 case. Regression models allowed the researchers to determine the binary and multivariate effects of different pandemic time phases on loneliness. The descriptive analysis revealed that loneliness increased after the Swiss government recommended physical distancing and slightly decreased after the Federal Council decided to ease these measures. According to the multivariate analysis, women, lower-income individuals, individuals living alone, individuals with no children, individuals unsatisfied with their contact with neighbors, and individuals interviewed after the physical distancing recommendations were more likely to report greater loneliness. The results suggest the pandemic has affected older adults' subjective evaluations of their subjective loneliness, and these findings help illustrate the pandemic's outcomes.

Keywords: social isolation, SARS-CoV-2, social contact, Switzerland, older adult, COVID-19, corona

INTRODUCTION

The current coronavirus disease 2019 (COVID-19) and the governmental recommendations stemming from it have created a pattern of physical distancing worldwide, particularly for adults aged 65+. Millions of people either have been or remain quarantined in their homes as countries have implemented physical distancing measures to contain COVID-19 infections. This social isolation can lead to feelings of loneliness, which, if prolonged, can be detrimental to mental health and well-being (Banerjee and Rai, 2020).

Although previous research has shown that subjective loneliness can be intensified in older adults by negative, stressful situations (Hensley et al., 2012), less is known about the COVID-19 pandemic's influence on loneliness in this population (Vahia et al., 2020). This research, therefore, investigated differences in loneliness before and during the pandemic to explain COVID-19's effects on subjective loneliness among adults aged 65+ in Switzerland.

Theoretical Assumptions

Loneliness is a complex psychosocial concept (Dykstra, 2009). This study defined loneliness as "the unpleasant experience that occurs when a person's network of social relations is deficient in some important way, either quantitatively or qualitatively" (Perlman and Peplau, 1981, p. 31). Loneliness can, therefore, be considered the subjective feeling of lacking social contact. Previous research has shown that socially isolated persons are at a greater risk of loneliness (de Jong Gierveld et al., 2006). However, socially isolated people are not necessarily lonely, and lonely people are not necessarily socially isolated (Hawkley and Cacioppo, 2010). Where people rest on the subjective loneliness continuum depends on their expectations and current situations (Dykstra, 2009).

Age is not a valid predictor of loneliness; nevertheless, meaningful social contacts are important for healthy aging (Holmén and Furukawa, 2002). COVID-19 has confronted older adults, first, with social isolation and, second, with the stress of not seeing family or friends and of finding themselves in the "at risk group." Stressful reminders of "being in need" may produce negative self-perceptions, resulting in loneliness (Hwang et al., 2020).

Research Aim

This research investigated the association between subjective loneliness and different time phases of the pandemic to explain COVID-19's impact on subjective loneliness among adults aged 65+. The authors expected that individuals interviewed after Switzerland's first governmental recommendations for maintaining physical distancing would report greater subjective loneliness.

MATERIALS AND METHODS

Participants

This study was based on data from a representative survey (Swiss Survey 65+) of 1,990 adults aged 65+ living in Switzerland. The survey initially focused on older adults' resources for maintaining autonomy in their own households; therefore, it was not constructed as a pandemic-related survey. Nevertheless, data collection occurred both before and after the first confirmed COVID-19 case in Switzerland (February 25, 2020), the first confirmed COVID-19-related death in Switzerland (March 5, 2020), and the Swiss Federal Council's decision (March 16, 2020) to introduce "extraordinary situation" measures for public protection.

From January to May 2020, 1,900 people aged 65+ were interviewed using a computer-assisted telephone interview (CATI) approach supplemented by paper-and-pencil surveys. The mean age of the sample was 72.74 years (SD: 5.18; age range: 65–95), and 42.8% of respondents were female. Based on media releases from the Swiss Federal Office of Public Health (FOPH) regarding the government's COVID-19 response, the sample was divided into four subgroups according to interview date.

- Phase 1 (Jan 27–Mar 6): Start of survey to Federal Council "call for special protection of older adults" (FOPH, 2020a), ($n = 391$).
- Phase 2 (Mar 7–Mar 16): Up to Federal Council declaring an "extraordinary situation" (FOPH, 2020b), ($n = 582$).
- Phase 3 (Mar 17–Apr 8): Up to Federal Council deciding to gradually ease the shutdown (FOPH, 2020c), ($n = 757$).
- Phase 4 (Apr 9–May 5): Up to the end of data collection, ($n = 260$).

Table 1 describes the sample and subgroups.

Measures

Subjective loneliness was assessed via a shortened, six-item version of the (de Jong Gierveld and van Tilburg, 1999) Loneliness Scale: *There are plenty of people I can lean on when I have problems; I often feel rejected; There are many people I can trust completely; I miss the pleasure of the company of others; There are enough people I feel close to; I miss having a really close friend.* Participants answered the items on a five-point scale (1 = does not apply at all, 5 = fully applies). The six items loaded on one factor, with factor loadings from 0.63 to 0.74. Cronbach's alpha for the scale was 0.783. The mean (M: 1.78, SD: 0.724) of all items was calculated, with higher scores reflecting greater loneliness. Time-related subgroups were selected via FOPH media releases, as described above.

Covariates, evaluated as important loneliness predictors in previous research (Vozikaki et al., 2018), included chronological age in years; sex (0 = male, 1 = female); educational level (1 = preprimary education, 5 = second state of tertiary education); monthly household income (1 = up to 1,200 CHF [Swiss francs], 9=over 15,000 CHF); living alone (0 = no, 1 = yes); having children (0 = no, 1 = yes); living in a rural area (0 = no, 1 = yes); and overall subjective satisfaction about contact with neighbors [one item("How satisfied are you about your contact with your neighbors?") measured on an 11-point scale (0 = completely dissatisfied, 10 = completely satisfied)].

Analytical Strategy

First, the Loneliness Scale mean values, divided into the four time-related subgroups, were graphically presented to show value changes. Second, single regression models were calculated to determine the binary effects of all independent variables on loneliness. Third, a multiple hierarchical linear regression model was employed to analyze the predictors of loneliness. Missing data were excluded. All analyses were conducted using SPSS 26 software.

RESULTS

Table 1 shows the descriptive statistics for the sample and the four subgroups. **Figure 1** presents the Loneliness Scale means for each time-related sub-group. Loneliness increased from the first to third subgroups and decreased from the third to fourth subgroups.

Parameter	Scale	Study sample (N = 1,990)	Subgroup 1 [Jan 27 to Mar 6] (n = 391)	Subgroup 2 [Mar 7 to Mar 16] (n = 582)	Subgroup 3 [Mar 17 to Apr 8] (n = 757)	Subgroup 4 [Apr 9 to May 5] (n = 260)
		% or mean	% or mean	% or mean	% or mean	% or mean
Gender	Female	42.8	56.0	33.5	37.1	60.4
	Male	57.2	44.0	66.5	62.9	39.6
Age	Mean[a]	72.74	74.51	72.10	72.24	72.95
Living alone	Yes	26.5	30.7	23.8	27.5	23.3
	No	73.5	69.3	76.2	72.5	76.7
Education	Mean[b]	2.94	3.18	2.93	2.77	3.04
Income	Mean[c]	5.33	5.11	5.56	5.36	5.14
Children	Yes	85.6	88.0	85.6	85.1	83.8
	No	14.4	12.0	14.4	14.9	16.2
Living area	Non-rural	76.7	69.3	78.4	80.2	74.2
	Rural	23.3	30.7	21.6	19.8	25.8
Satisfaction about contact with neighbors	Mean[d]	7.90	7.98	7.91	7.74	8.22
Loneliness	Mean[e]	1.79	1.69	1.78	1.84	1.79

[a] Age range: 65–95; [b] Education scale (1 = preprimary education, 5 = second state of tertiary education); [c] Income scale (1 = up to 1,200 CHF, 9 = over 15,000 CHF); [d] Satisfaction with contact with neighbors (0 = completely dissatisfied, 10 = completely satisfied); [e] Loneliness scale (1 = low, 5 = high).
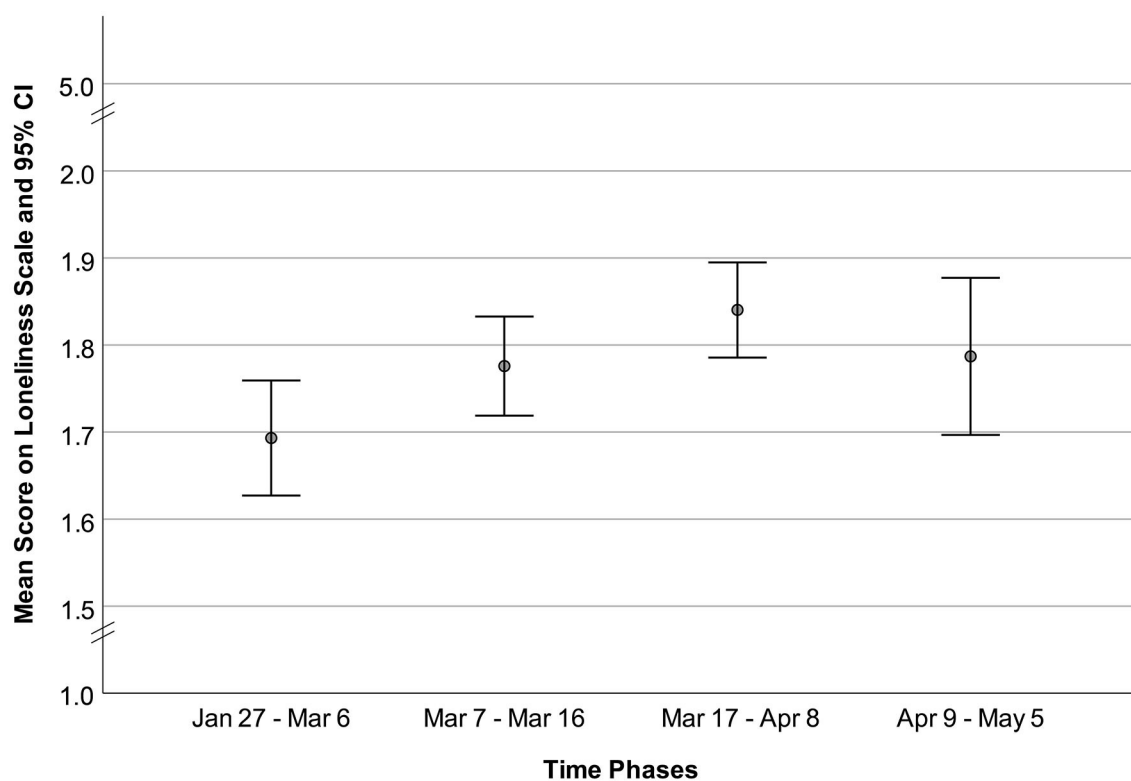
FIGURE 1 | Differences in loneliness between the four time groups.

Table 2 shows the bivariate relationships between the four subgroups and the covariates with the independent variable "loneliness." In the single gross models, loneliness was statistically significantly associated with the differences between the first subgroup and the third subgroup, revealing that the increase in loneliness was significant for comparing the first

TABLE 2 | Linear Regression analyses with loneliness as dependent variable.

Parameter	Scale	Single gross models	Model A: standard demographics	Model B: living situation	Model C: full model
		Beta	Beta	Beta	Beta
Age	65–95	0.026	0.019	−0.023	−0.008
Gender	Female (ref. male)	−0.015	0.003	0.050*	0.059*
Education	1–5	−0.086***	−0.005	−0.047	−0.036
Income	1–9	−0.180***	−0.183***	−0.064*	−0.073**
Living alone	Yes (ref. no)	0.217***		0.198***	0.198***
Children	Yes (ref. no)	−0.112***		−0.060**	−0.059*
Rural area	Yes (ref. no)	−0.029		−0.006	0.002
Satisfaction about contact with neighbors	0–10	−0.367***		−0.371***	−0.369***
Subgroup 2 [Mar 7–Mar 16]	(ref. subgroup 1 [Jan 27–Mar 6])	0.052			0.089**
Subgroup 3 [Mar 17–Apr 8]	(ref. subgroup 1 [Jan 27–Mar 6])	0.099**			0.095**
Subgroup 4 [Apr 9–May 5]	(ref. subgroup 1 [Jan 27–Mar 6])	0.044			0.064*
Model fit			$F_{(4, 1638)} = 14.811$; $p < 0.001$; $R^2 = 0.035$	$F_{(8, 1609)} = 52.593$; $p < 0.001$; $R^2 = 0.208$	$F_{(11, 1609)} = 39.602$; $p < 0.001$; $R^2 = 0.214$

Dependent variable: Loneliness scale (scale 1–5); *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

TABLE 3 | Linear Regression Analyses with Loneliness in Comparison with Different Subgroups as Reference.

Parameter	Model A: ref. subgroup 1	Model B: ref. subgroup 2	Model C: ref. subgroup 3	Model D: ref. subgroup 4
	Beta	Beta	Beta	Beta
Subgroup 1 [Jan 27–Mar 6]	–	−0.082**	−0.081**	−0.079**
Subgroup 2 [Mar 7–Mar 16]	0.089**	–	0.001	0.004
Subgroup 3 [Mar 17–Apr 8]	0.095**	−0.001	–	0.002
Subgroup 4 [Apr 9–May 5]	0.064*	−0.003	−0.002	–
Model fit	$F_{(11,1609)} = 39.602$; $p < 0.001$; $R^2 = 0.214$	$F_{(11,1609)} = 39.602$; $p < 0.001$; $R^2 = 0.214$	$F_{(11,1609)} = 39.602$; $p < 0.001$; $R^2 = 0.214$	$F_{(11,1609)} = 39.602$; $p < 0.001$; $R^2 = 0.214$

Dependent variable: Loneliness scale (scale 1–5); Controlled for: Age, gender, education, income, living alone, children, rural area, and satisfaction about contact with neighbors; *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

subgroup to the third subgroup. All covariates, except age, gender, and rural area, were statistically significantly associated with loneliness.

Table 2 also shows the hierarchical linear regression analyses for the multivariate predictors of loneliness. In model (A), only income was a statistically significant loneliness predictor. In model (B), gender, income, living alone, having children, and being satisfied about contact with neighbors were statistically significant loneliness predictors. In the full model (C), subgroups two through four, compared to the first subgroup and the same covariates as in (B), were statistically significant loneliness predictors. Females, individuals with lower incomes, individuals living alone, individuals with no children, individuals who were dissatisfied about their contacts with neighbors, and individuals

who were interviewed after March 6, 2020, were more likely to report greater loneliness.

Supplementary analysis addressed potential differential findings with other subgroups as references in the linear regression analysis. Findings from those additional analyses confirmed the previous results; only the difference between the first time phase and time phases two through four significantly predicted loneliness (**Table 3**).

DISCUSSION

This study explored the impact of different COVID-19-related time phases on subjective loneliness among

adults aged 65+. As the authors hypothesized, loneliness was associated with the time periods in which the interviews took place. Individuals interviewed before the Federal Council called for the special protection of older adults reported lower loneliness than those interviewed later. Thus, the results suggest that the pandemic—more specifically, the Federal Council's call for the special protection of older adults through physical distancing—affected older adults' subjective evaluations of their loneliness.

Subjective loneliness increased between the first and second and between the second and third subgroups, but it slightly decreased, as a possible "normalization" of loneliness, after the Federal Council called for easing the official COVID-related restrictions. Other recent studies have also found these up-and-down movements, indicating that loneliness increased during the first weeks of the COVID-19 lockdown and decreased thereafter (Buecker et al., 2020; Höglinger et al., 2020). However, the present data collection ended on May 5, 2020, and, therefore, further research is needed to evaluate future developments.

Nevertheless, from the available data, it may be assumed that recommendations for older people to maintain physical distancing directly or indirectly affected their loneliness—probably by (a) limiting social contact opportunities; (b) making older individuals reflect on their social/support networks, potentially evaluating them as frail; (c) labeling older adults as "at risk," possibly causing them to be shunned; and (d) making older individuals feel lonely because society considered them old and frail and, therefore, lonely.

In addition to this time-related effect, loneliness factors known from previous research—being female, having low income, living alone, having no children, and having no good contact with neighbors—were also found. COVID-19 has affected subjective loneliness, but this does not eliminate existing inequalities. Current research states that, during a pandemic, woman, and people with low incomes are likely to be loneliest (Bu et al., 2020). Therefore, existing inequalities among older adults should also not be neglected during the pandemic. Though the media often considers older adults as a homogeneous "at risk group," this study found no age-related association with loneliness. Older adults should not be viewed as a homogenous "vulnerable" group, and undifferentiated, blanket measures that disproportionately exclude older adults are often based on grossly simplified age stereotypes, which can reproduce age discrimination (Ayalon et al., 2020; Losada-Baltar et al., 2020).

Furthermore, these results confirmed that not all older adults reported loneliness; those who did should be asked what could help them overcome those feelings. This calls for an individual—instead of a sweeping, group—view of loneliness, and gerontological social work responses must be tailored to individual needs (Berg-Weger and Morley, 2020).

Despite this study's strengths, several limitations must be noted. First, this research focused on Switzerland, so the findings have limited generalizability. Second, the existing data provided only a cross-sectional view. Third, because of the study variables' limited width, the authors could not control for other important background factors, such as measurements of quantity/quality and valuations of social contacts, personality, or attitudes toward COVID-19 governmental restrictions. Furthermore, those additional variables could help to set the new COVID-19-contextual findings in relation to the existing research literature about subjective loneliness among older adults. Clearly, further studies with longitudinal designs and wider variable ranges are required to examine this topic in more detail.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

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Attitude to COVID-19 Prevention With Large-Scale Social Restrictions (PSBB) in Indonesia: Partial Least Squares Structural Equation Modeling

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There is a continuous increase in the number of COVID-19 cases in Indonesia. To control its spread, the government has implemented several strategies, such as policies associated with large-scale social restrictions (Indonesian: Pembatasan Sosial Berskala Besar or PSBB). The purpose of this study is to determine the variables that influence attitudes toward PSBB policies in Indonesia. This is a cross-sectional study with data obtained from 856 respondents from all provinces in Indonesia using the partial least squares and structural equation model (PLS-SEM). A total of 23 indicators were used to examine these policies, which were grouped into five variables: benefits of the PSBB (5 indicators), positive perception (5 indicators), negative perception (3 indicators), threatened perceptions of COVID-19 (5 indicators), and attitude toward the PSBB policy (5 indicators). The model explains over 50% of attitudes exhibited toward PSBB policy implementation and how it is influenced by the perceived benefits, negative and positive perceptions as well as the threat associated with COVID-19. The policy of stay at home, physical distancing, and always using face masks needs to be continued for the public to have a supportive attitude of the PSBB policy in preventing the transmission of COVID-19.

Keywords: attitude, perception, COVID-19, Indonesia, modeling

INTRODUCTION

The COVID-19 pandemic, which initially started in Wuhan, China, has spread to over 200 countries worldwide. On August 12, 2020, there are 20,162,474 cases were reported, with ∼737,417 deaths (1–4). In Indonesia, according to government data on August 12, 2020, there were 130,718 cases and 5,903 deaths (5).

According to the World Health Organization (WHO), the COVID-19 virus can be transmitted from an infected person to others through droplets when coughing or sneezing as well as by touching objects infected with the virus (6). The WHO recommends the mandatory use of face masks (7, 8), reducing crowds by shutting down workplaces, schools, places of worship, and other forms of social gathering. Furthermore, physical distancing needs to be maintained by staying at a distance of more than 2 m away from other people (9). Regular washing of hands, disinfecting frequently touched surfaces, and desisting from touching the mouth, nose, and eyes are also

recommended (10). However, social distancing was found to be less accepted by the public than other means of control, as evidenced by a continuous increase in transmission at the local level and in communities outside the home. The Indonesian government has enacted regulation No. 21 of 2020 concerning large-scale social restrictions (PSBB) to help increase control over the spread of COVID-19.

These restrictions include closing workplaces, schools, public transportation, and socio-cultural, religious, and community activities in public places or facilities (11). The criteria for the application of PSBB are the significant and rapid increase in the number of cases and deaths from COVID-19 disease as well as epidemiological links with similar incidents in other regions or countries.

All regions in Indonesia are encouraged to implement physical and social distancing policies to prevent the spread of this virus, which is currently at the community transmission level (12, 13). Citizens in almost all the provinces in Indonesia are at risk of being infected with this virus; therefore, they are encouraged to restrict their activities.

Unfortunately, public awareness to prevent the transmission of COVID-19 is still very low; which is demonstrated by the presence of people who actively live their lives in public places. Many studies have been conducted on the attitudes and perceptions of health workers (14, 15). However, there has not been any published research regarding people's perceptions and attitudes toward PSBB policy. This study adopted a theoretical framework from the research carried out in Kenya on health workers' perceptions and attitudes toward national health care (16) to create PSBB policies. Therefore, through structural equation modeling analysis, the right variables are formed to support these policies.

METHODOLOGY

Conceptual Model

The theoretical model adopted in this study was associated with the perceptions and attitudes of health workers in allocating national nursing resources (16) as well as perceptions and attitudes related to tourism (17, 18). The hypothesized model comprised of five latent constructs on the PSBB policy is influenced by the benefits, positive perception, negative perception, perceived threat of COVID-19, and attitude toward PSBB policy, as shown in **Figure 1**. The path direction represents the positive (+) and negative (−) effects of the relationship. This study examines the suitability of the model and hypothesis with SEM-PLS.

Study Design and Data Collection

This is a cross-sectional study based on a web-based survey used to measure the five variables on attitudes toward PSBB policy influenced by the benefits, positive perception, negative perception, and perceived threat of COVID-19. Questionnaires related to the perceptions of health workers and mechanisms for national nursing resources for COVID-19 prevention were developed by the Ministry of Health (14, 16). Respondents answered these questions using a five-point Likert scale: 1 (strongly disagree), 2 (disagree), 3 (neutral), 4 (agree), and 5 (strongly agree). This tool was used because of its simplicity and ease of use. Each question item was discussed with experts to obtain the necessary suggestions and ways to further prevent the virus. The online questionnaire was tested for validity and reliability by 50 respondents, which led to a total of five invalid questions. Data were anonymously collected from respondents in 34 provinces through an online survey (19) using Google forms. It was also distributed by the Indonesian health professional organizations through WhatsApp from May 1 to May 14, 2020.
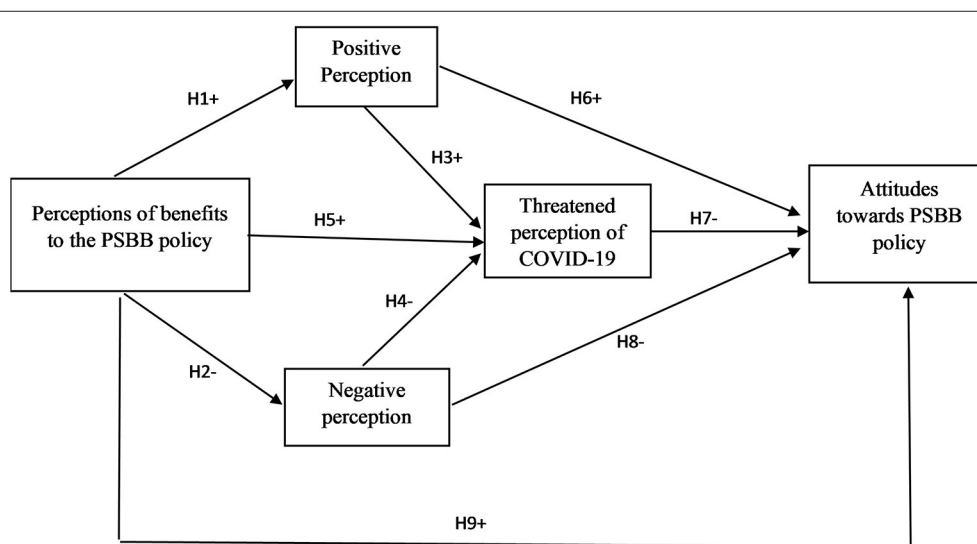
FIGURE 1 | Hypothesized structural relationships of perception and attitudes toward PSBB policy.

TABLE 1 | Data description.

Composite	Indicator	Definition
Perception of benefits from PSBB	Var1a	Reduce the risk of transmitting COVID-19
	Var1b	Prevent transmission
	Var1c	Can immediately stop its transmission
	Var1d	Improves community discipline
	Var1e	Increases community participation
Positive perception	Var2a	Supports the use of masks
	Var2b	Participate in the prevention of COVID-19
	Var2c	Need to protect families from the virus
	Var2d	Support the stay at home policy
	Var2e	Support studying and working from home.
	Var2f*	Get help or facilities such as food assistance, electricity bills, given a mask from the government
Negative perception	Var3a*	Make a limited income
	Var3b	Restricting social activities outside the home
	Var3c	Not permitted to leave the area
	Var3d*	Increase in the cost for internet usage
	Var3e	Migrant workers are prohibited from returning to their hometown (mudik)
	Var3f*	Basic needs become limited and expensive
Threatened perception of COVID-19	Var5a	Fear of being infected
	Var5b	Feeling afraid that foreign guests are coming with COVID-19
	Var5c	Fear of family members contracting the virus
	Var5d	Fear a family member died because of COVID-19
	Var5e	Scared of leaving the house
	Var5f*	Feeling anxious on news related to the virus
	Var5g*	Scared of the sanctions associated with violating the policy
Attitudes toward PSBB policy	Var4a	Participate in the socialization of PSBB policies
	Var4b	Stay at home
	Var4c*	Work from home
	Var4d	Reduce social activities
	Var4e	Physical distancing
	Var4f	Migrant workers were not allowed to return to their hometowns

These indicators were not included in latent variables due to the multicollinearity criteria of PLS-SEM.

Respondent

The respondents who participated in the online survey were above 17 years old and had resided in Indonesia for more than 6 months. They provided informed consent before filling out the

TABLE 2 | Sociodemographic characteristics of respondents.

Province	Frequency (N = 856)	Percent
Bali	183	21.38
South Sulawesi	67	7.83
Riau	66	7.71
West Nusa Tenggara	61	7.13
East Java	86	10.05
Central Java	48	5.61
West Java	128	14.95
DI Yogyakarta	12	1.40
DKI Jakarta	65	7.59
Bengkulu	32	3.74
Banten	21	2.45
South Sumatra	13	1.52
North Sumatra	9	1.05
West Sumatra	7	0.82
Nanggroe Aceh Darussalam	5	0.58
Lampung	15	1.75
Kepulauan Riau	9	1.05
East Kalimantan	12	1.40
South Kalimantan	8	0.93
West Papua	3	0.35
East Nusa Tenggara	3	0.35
Sulawesi Tenggara	3	0.35
Age (years)		
17–24	334	39
25–29	146	17.1
30–34	115	13.4
35–39	89	10.4
40–44	69	8.1
45–49	42	4.9
50–54	39	4.6
55–59	16	1.9
60+	6	0.7
Gender		
Male	606	70.8
Female	250	29.2
Education		
Without education	7	0.8
Primary education	16	1.9
Secondary education	471	55.0
Diploma	145	16.9
Bachelor's degree	172	20.1
Higher than bachelor's degree	45	5.3
Occupation		
Government officer	126	14.7
Health workers	130	15.2
Lecturer	23	2.7
Teacher	7	0.8
Housewife	56	6.5
College student	40	4.7
Student	245	28.6

(Continued)

Province	Frequency (N = 856)	Percent
Industrial staff	141	16.5
Self-employed	55	6.4
Others	33	3.9

questionnaire and were paid by the sponsor. A total of 868 people filled out the data, with 856 eligible responses.

Several steps were taken to prevent missing data (20). First, each respondent received an explanation of the purpose of the study by filling out documents associated with their informed consent. Second, in the web-based questionnaire survey, an automatic system was used to fill out the data, and it was discontinued when blank. Third, respondents' data were collected anonymously to ensure confidentiality. Listwise deletion was used when data were missing. Incomplete data that did not meet the requirements were not used in this study.

This study used a partial least squares (PLS-SEM) composite scheme with the SmartPLS 3.0 software to analyze four perception variables on attitudes toward PSBB policy consisting of 30 indicators. Partial least squares were used to create a structural model with the ability to map paths with many variables simultaneously. This analysis was used to predict the multicollinearity among variables (21). **Table 1** shows the theoretical models proposed in this study, which examines the effect of PSBB policy influenced by the benefits, positive perception, negative perception, and perceived threat of COVID-19.

Measurement of Variables

This study consists of five variables measuring 30 indicators using a Likert scale of 1 (strongly disagree), 2 (disagree), 3 (neutral), 4 (agree), and 5 (strongly agree). The following constructs are part of this model:

The attitude toward the PSBB policy is the dependent variable, which means that the respondent's attitude is carried out in daily life. It is measured by six indicators, consisting of those who participate in the socialization of PSBB policies: stay at home, work from home, reduce social activities, physical distancing, and migrant workers who do not return to their hometown or village during or before major holidays (mudik).

The perception of benefits from the PSBB policy is associated with assessing the policy implemented by the government that benefits the community. It consists of six indicators that reduce the risk of transmitting COVID-19 and prevent its spread, thereby improving community discipline and participation.

Positive perception is associated with respondent's assessments of the PSBB policy, which is in line with the expectations of its regulations. It comprises of six indicators: support the use of masks, participate in preventing COVID-19, protecting families from the virus, not leaving the house, studying and working from home, and getting help or convenience such as food and bills assistance, and masks from the government.

Negative perception is the respondent's assessment of PSBB policies that are not in line with their expectations. It consists of six indicators: receiving limited income, restricting social activities outside the home, not permitted to leave the area, increasing cost for internet usage, migrant workers are prohibited from returning to their hometown (mudik), and basic needs become limited and expensive.

Threatened perception of COVID-19 frightens respondents. It consists of seven indicators, namely fear of being infected, increased by foreign guests, family members contracting the virus, fear of the death of a family, scared of leaving the house, feeling anxious about news related to the virus, and scared of the sanctions.

Statistical Procedure

Structural equation models are analyzed in two stages: measurement and structural model analyses (22). The first stage describes the model being measured by connecting the constructs and indicators according to the theory. After obtaining the quality of the measured data, a structural model is used to determine the relationship between the construction or hypothesis model. This is carried out to make valid and reliable measurement scales to prove the structural model hypothesis. This study used the Smart-PLS 3.2.7. software.

Ethical Approval

The study's ethical clearance was obtained from the Public Health Faculty, Universitas Indonesia (No. 198/UN2.F10. D11/PPM.00.02/2020). This study was carried out in accordance with the Declaration of Helsinki and the recommendations of those committees with written informed consent from all participants.

RESULTS

The respondents in the provinces were distributed as follows: Bali (21.3%), West Java (14.9%), East Java (10%), South Sulawesi (7.8%), Riau (7.7%), and Central Java (5.6%) (**Table 2**). The Java-Bali region had a relatively high trend of increasing cases compared to other provinces, due to the population density and higher mobility. The demographic characteristics of the 856 respondents were aged 17–24 years (39%). The highest gender distribution, education level, and employment type were male (70.8%), secondary education (55%), and students (28.6%), respectively. Furthermore, the health workers and government officers were 15.2 and 14.7%, respectively.

Measurement Model
Composite Mode A

The composite measurement model in mode A was assessed in terms of individual item reliability, discriminant validity, convergent validity, and construct reliability, which were analyzed using the through-loading factors shown in **Figure 2**.

Composite reliability is more precise than internal consistency. It can be used with PLS-SEM to accommodate different loading indicators. Validity assessment was carried out by calculating convergent and discriminant validities. **Table 3**

FIGURE 2 | Research model.
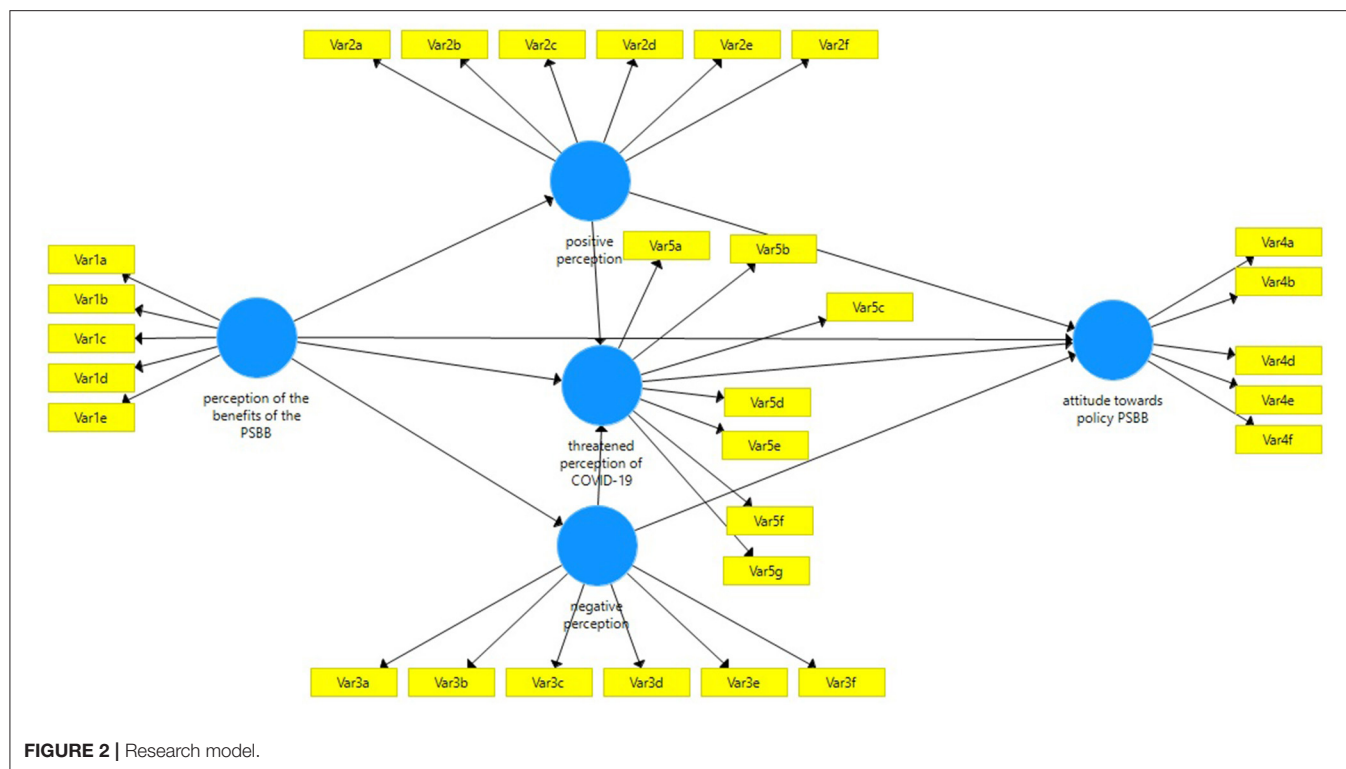
TABLE 3 | Validity and reliability measurement.

Composite	Cronbach's alpha	Dijikstra-Henseler's rho	Composite reliability (CR)	Average variance extracted (AVE)
Attitude toward PSBB policy	0.865	0.774	0.899	0.599

illustrates the cutoff value of 0.7 for 3 measurements, namely Cronbach's alpha, Dijkstra-Henseler's rho coefficients, and composite reliability. The third convergent validity is proven because each construct's average variance extracted (AVE) is higher than 0.5. **Table 3** shows that the measurement model fits the criteria.

Table 4 presents the results of discriminant validity through the Heterotrait-Monotrait (HTMT) correlation ratio. All constructs are in accordance with the discriminant validity because the confidence interval does not contain a zero value. This means that each variable is different from one another.

The data examined above in the measurement model show that the construct is reliable and valid.

Composite Mode B
The composite measurement model in mode B was assessed in terms of the collinearity between the indicators, significance, and relevance of the external weights. First, this was carried out by removing the indicator when it exceeded the value of the impact factor variance (VIF = 3). As a result of this process, only the indicators shown in **Table 1** are not collinear. Second, the relevance of weights was analyzed, as shown in **Figure 3**, with the relevance of indicators in construction for latent variables. Finally, 10,000 subsamples were used to start bootstrapping,

and to determine the ability to the outside weight significantly different from zero. Indicators with weights were insignificant, with a significant loading of 0.50 above the relevant values, as shown in **Table 5**.

Structural Model
After verifying the appropriate values of the construction measurements, an assessment of the structural model was carried out using 10,000 resampling bootstraps. The path coefficients and the significance level of their 10,000 resampling bootstraps are reported in **Table 6** and **Figure 3**. Furthermore, **Table 6** also shows that the VIF construction ranges from 1,000 to 1,700, indicating that there is no collinearity between variables. This study also assesses quality by examining whether the predictive relevance of the whole model has a Q^2-value above zero; therefore, it fits in the model predictions. The coefficient of determination (R^2) also exceeds 0.1 for endogenous latent variables. Therefore, the construct has an acceptable predictive power quality.

Table 6 shows that the PSBB policy influenced by the benefits, positive, negative, and perceived threat of COVID-19 directly influence community attitudes (p values < 0.001 and 0.001). Furthermore, each variable has a positive relationship with attitude, and the indirect effect can be seen from the value of

HTMT inference*	Original sample	Sample mean	5%	95%
Attitude toward PSBB➜benefit	0.534	0.533	0.445	0.609
Attitude toward PSBB➜feel threatened	0.479	0.478	0.372	0.576
Attitude toward PSBB➜positive perception	0.765	0.765	0.683	0.837
Attitude toward PSBB➜negative perception	0.504	0.506	0.407	0.619

*Significance, the 95% confidence interval can be corrected using the bootstrap procedure with 10,000 replications.
HTMT, Heterotrait–Monotrait.

FIGURE 3 | SEM-PLS results model.
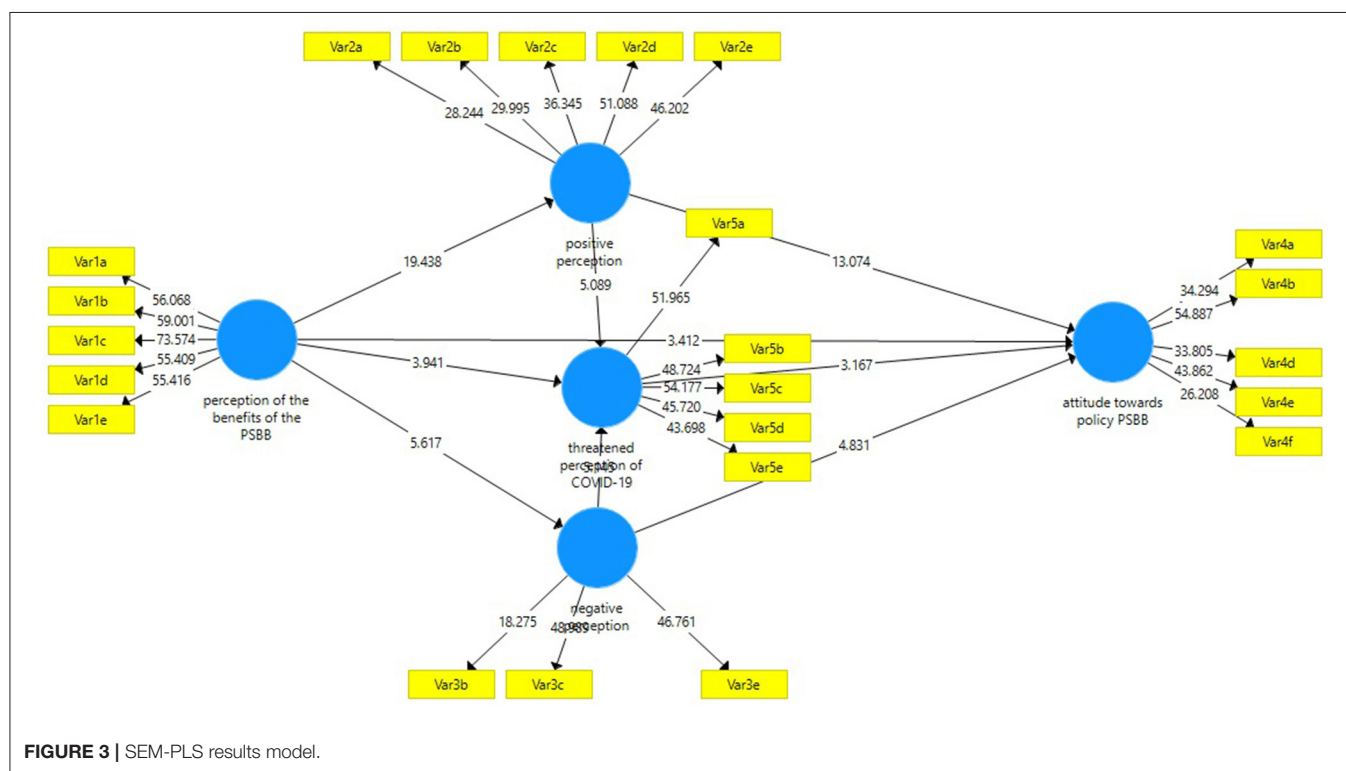
VAF, which indicates that the proportion mediated by the total effect of feeling threatened through negative perception is 7.6%, as shown in the indirect effect in **Table 6**. This model explains that the benefits, positive, and negative perceptions influence 52.9% of attitudes toward PSBB policy, and the perceived threat of COVID-19.

DISCUSSION

In this cross-sectional study (23), PLS-SEM was used to explore the determinant relationships of perceptions and attitudes toward COVID-19 policy in Indonesia. The general population in several provinces in Indonesia were used to represent the conditions in each region. The PSBB policy is not carried out simultaneously in all regions, although all of them have the potential risk of COVID-19 transmission.

The study analyzed a total of five variables with 30 indicators that influence attitudes toward the policies of PSBB. After analysis using PLS-SEM, 23 indicators were obtained. This model

explains that attitudes toward PSBB policy are influenced by the benefits, positive and negative perceptions, and perceived threat of COVID-19.

Policymakers need to understand how to prevent the transmission of COVID-19 as opening public access to infrastructures without considering epidemiological studies can lead to rapid transmission (24). This study describes the attitudes of the community in supporting large-scale social restriction policies carried out in Indonesia. A positive attitude toward this policy causes the community to comply with the regulations willingly and understand the benefits.

Most of the survey respondents were located on Java Island. The distribution of respondents does not represent all provinces in Indonesia; however, Java Island is densely populated, and high population density is one of the risks in the spread of COVID-19 (25). In particular, the challenges are greater in limiting population mobility and social distancing (26). Studies in China also show that people infected with COVID-19 tend to be in densely populated areas (27). A study in Brazil also found that

TABLE 5 | Significance of weights.

	Original sample (O)*	t	Loading	Lo95	Hi95
Perception of benefits					
Var1a	0.248	24.965	0.855	0.228	0.268
Var1b	0.252	25.275	0.869	0.230	0.270
Var1c	0.224	26.016	0.851	0.207	0.241
Var1d	0.226	22.641	0.831	0.207	0.247
Var1e	0.230	23.058	0.828	0.212	0.250
Positive perception					
Var2a	0.224	22.448	0.758	0.204	0.242
Var2b	0.244	22.707	0.739	0.225	0.265
Var2c	0.226	25.446	0.808	0.209	0.243
Var2d	0.280	25.114	0.833	0.259	0.304
Var2e	0.289	23.723	0.809	0.266	0.314
Negative perception					
Var3b	0.273	7.996	0.725	0.197	0.331
Var3c	0.433	17.938	0.879	0.386	0.480
Var3e	0.493	15.675	0.855	0.436	0.559
Attitude toward PSBB policy					
Var4a	0.251	21.793	0.759	0.229	0.275
Var4b	0.273	28.682	0.856	0.255	0.292
Var4d	0.232	24.450	0.803	0.213	0.251
Var4e	0.260	23.316	0.829	0.239	0.282
Var4f	0.226	22.431	0.768	0.207	0.247
Threatened perception of COVID-19					
Var5a	0.229	18.817	0.839	0.206	0.253
Var5b	0.232	20.270	0.845	0.209	0.255
Var5c	0.248	19.655	0.862	0.221	0.270
Var5d	0.234	17.452	0.841	0.205	0.259
Var5e	0.262	13.899	0.773	0.229	0.300

*Significance in $p < 0.001$, t statistic, and 95% bias-corrected confidence interval performed by a bootstrapping procedure with 10,000 replications.

air transportation, population density, and temperature affect the spread of COVID-19 (28).

Most of the respondents in the survey were male and aged 17–24 years. The PSBB policy encouraged school closure and home study through electronic media and online applications. Students' perceptions of the benefits and positive attitude toward PSBB tend to influence their compliance with PSBB policies. Efforts are needed to increase student awareness in preventing the transmission of COVID-19 (29). School closure policies must also be supported by strict social distancing policies (11).

Through a cross-sectional approach, PLS-SEM analysis can be carried out quickly in the general population. This model is designed to determine the respondent's attitude toward the PSBB policy at a specific time. However, it is necessary to carry out further research with a longitudinal approach to determine the comparison of changes in people's attitudes toward the PSBB policy according to the observation period.

The community's attitude as a dependent variable is associated with participating in socializing PSBB, staying at home, reducing social activities, maintaining a safe distance from others, and migrant workers not returning to their hometown. This is consistent with the WHO recommendation to prevent transmission of COVID-19 on staying at home and maintaining a safe distance of more than 2 m (30). These measures aim to stop the spread of the virus, which is transmitted from an infected person to another through droplets when coughing (31–33).

The city of Wuhan in China was locked down to prevent the rapid transmission of the virus (34). This policy was implemented under strict action, discipline, and punishment for violators, and food was provided for the population. However, in Indonesia, restrictions were placed on community activities such as schools, workplaces, and religious places, with access to markets and population logistics. The government also failed to cover the daily needs of the population and hopes that the transmission rate will be reduced through the PSBB policy.

The PSBB policy reduces the risk of COVID-19 transmission by preventing its spread and stopping its transmission through increased community discipline and involvement. The government has supported socialization through electronic platforms and social media, with teachers and community leaders providing adequate information on the benefits of the

TABLE 6 | Whole sample results.

	Path	t	p	Lo95	Hi95	f²	VIF
Direct effect							
Benefit➜positive perception	0.550	19.012	0.000	0.493	0.607	0.434	1.000
				$R^2 = 0.302$			
Benefit➜negative perception	0.221	5.493	0.000	0.151	0.303	0.051	1.000
				$R^2 = 0.048$			
Positive perception➜threatened perception	0.226	5.113	0.000	0.145	0.312	0.043	1.497
Negative perception➜threatened perception	0.204	5.343	0.000	0.139	0.288	0.048	1.098
Benefit➜threatened perception	0.179	3.981	0.000	0.095	0.269	0.028	1.443
				$R^2 = 0.210$			
Benefit➜attitude toward PSBB policy	0.109	3.471	0.001	0.047	0.170	0.017	1.484
Threatened perception➜attitude toward PSBB policy	0.124	3.224	0.001	0.046	0.191	0.026	1.270
Positive perception➜attitude toward PSBB policy	0.497	12.464	0.000	0.414	0.576	0.336	1.562
Negative perception➜attitude toward PSBB policy	0.219	4.888	0.000	0.137	0.316	0.089	1.150
				$R^2 = 0.529, Q^2 = 0.527$			
Indirect effect						VAF	
Benefit➜perception +➜threatened perception	0.170	5.787	0.000	0.118	0.233	20.8	na
Benefit➜perception +➜threatened perception attitude toward PSBB policy	0.365	12.712	0.000	0.311	0.424	15.3	na
Perception positive➜threatened perception➜attitude toward PSBB policy	0.028	2.585	0.010	0.008	0.048	7.6	na
Perception negative➜threatened perception➜attitude toward PSBB policy	0.025	2.474	0.013	0.008	0.044	5.2	na

ns, not significant. Significance, t statistics, and 95% confidence can be corrected. A bootstrap procedure performs the interval with 10,000 replications. VIF, Inflation of model variants in factors; VAF, variance recorded.

PSBB policy. It is expected that the public complies with this regulation due to the increase in public awareness.

Furthermore, increased understanding of the community causes positive attitudes such as supporting the use of masks, wanting to protect families from contracting the virus, supporting the idea of not leaving the house as well as learning, and working from home, and participating in the prevention of COVID-19 (35–37). Health education needs to be given to vulnerable populations infected with COVID-19, such as the elderly (38, 39) used to avoid stress (40). The use of masks is an easy, cheap, and effective way to prevent transmission (41); therefore, the WHO recommends its usage (42–44).

The negative perceptions toward the PSBB policy are limited social activities outside the home and not being allowed to leave the area or town. Therefore, traders, construction, and factory workers lost their income negatively affecting their socioeconomic status. Furthermore, those who have family outside their area were also prohibited from traveling. This makes the population uncomfortable with the PSBB policy, thereby leading to anxiety, lack of sleep, depression (16–28%), and stress (8%) (45).

The perception of being threatened with COVID-19 consists of a feeling of fear of being exposed to the virus, foreign guests coming into the country infected, and fear of leaving the house (46–48). It is also associated with the fear of family members being infected with the virus and the possibility of death. These perceptions encourage people to take the necessary preventive steps not leaving the house and adhering to the government's recommendation to conduct a PSBB.

Study Strengths and Limitations

The strengths of this research were determined by measuring the benefits, positive, negative, and perceived threat of COVID-19 in accordance with the use of PSBB. These perceptions can influence respondents' attitudes toward the PSBB policy. This model is usually used in social research in tourism as well as in the health sector (16–18, 49).

The PLS-SEM was chosen for component-based social research with formative construct properties. This approach is variant based and has the ability to estimate composites and factors (50, 51). It is also useful to predict the dependent variable within a large number of independent variables. In addition, through this approach, an appropriate structural equation model can be made with variables related to attitudes toward PSBB policy.

This study is limited by the use of online surveys, which are provided by the general public rather than specific targets. However, with the general public, there are various advantages, such as the ability to reach all groups in a broad range, depending on the PSBB policy. However, this situation was not uniform in all places, which had a non-concurrent implementation process.

Policy Implications and Future Research

This study is useful for policymakers, especially for health interventions and health education programs in efforts to control COVID-19. The PSBB policy with restrictions on community activities and entering and leaving the area. Schools and workplaces are closed, but learning activities can be carried out online. The PSBB is also supported by tracking and finding

people who are exposed (52). Efforts to control COVID-19 in other countries by limiting community activities at the beginning of the pandemic, such as lockdown implementations, have proven effective in reducing the transmission of the virus (53, 54). However, this approach has been reported to have an impact on psychological and economic factors in society (55–57).

The results of this study have implications for controlling COVID-19 in various regions, particularly in Indonesia. The public needs to obtain adequate educational awareness on the perception and benefits of the PSBB policy, which can positively impact the public's attitudes to abide by the policy. This study contributes to the addition of academic literature by applying the PLS-SEM to explore the relationship between attitudes toward PSBB and COVID-19 spread. Subsequent studies can be conducted in certain areas to control numerous factors by the timing of a particular PSBB implementation, to ensure that the impact is clear when compared to many regions with a non-concurrent PSBB period.

CONCLUSION

The PSBB policy needed to obtain adequate attention from the community to prevent the rapid transmission of COVID-19 in Indonesia. Furthermore, the attitude of those that support this policy tends to affect the successful implementation of this program. This model explains that 52.9% of attitudes toward PSBB policies are influenced by perceptions of the benefits of the PSBB policy, positive perceptions, negative perceptions, and perceptions of the threat of COVID-19. The policy of not leaving the house, keeping a safe distance, and always using face masks needs to be continued for the public to support the PSBB policy in preventing further transmission.

DATA AVAILABILITY STATEMENT

Derived data supporting the findings of this study are available from the corresponding author on request. Requests to access the datasets should be directed to Sang Gede Purnama, sangpurnama@unud.ac.id.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Public Health Faculty, Universitas Indonesia. The patients/participants provided their written informed consent to participate in this study. Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

AUTHOR CONTRIBUTIONS

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Brief Commentary: Why We Need More Equitable Human Resources for Health to Manage the Covid-19 Pandemic

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With this brief commentary we urge human resources for health (HRH), i.e., all people engaged in actions whose primary intent is to enhance health[1], to be more equitable if we want to minimize the disproportionate impact of covid-19 in regions with unfair health systems such as the United States (U.S.). As it is so often the case in societies with inequitable access to, and inappropriate distribution of public health resources, crises like the outbreak of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) hits disadvantaged groups the hardest. We see that occurring not only in low-income countries in Africa and South-America with constrained health systems, but also in Europe (1) and the U.S. (2) in particular. While the virus does not discriminate, inappropriate health systems certainly do. Race, ethnicity, and class disparities, aggravated by decade-long exclusion from high-quality health workers, health care services and comprehensive insurance, are reflected both in the virus's morbidity and mortality rates (3–5) as well as the fallout from the unfolding socioeconomic impact across communities (2).

Indeed, entrenched health inequity [i.e., avoidable and remediable consequences of structural health injustices (6)] between groups of people presented a global health threat long before COVID-19 (7), yet the pandemic has significantly compounded the impact of inappropriate medical care systems, capacities of health workers and technologies on health disparities (8). Therefore, if we are to advance health equity (9) and population health (10), not only as a public health issue, but also as an urgent matter of justice in the health systems' responsiveness (7), more emphasis on social justice and equity in the decision making process of health system's resources generation and allocation is needed (11). This is particularly true for equity in HRH (11).

We suggest that the path to improving HRH equity entails inclusive governance that creates a fair and accessible health care system with an appropriate distribution of competent and motivated health workers. The latter needs to be fit for purpose and practice in their respective context, and appropriately meet the varying needs of all communities they serve, especially the most underserved. We argue that HRH equity is the foundation for accelerating universal health coverage (UHC) (11) which may ultimately lead toward attaining Sustainable Development Goals such as Health and Well-being for all (Goal 3) (12). Here, we highlight how pre-existing health and HRH inequities rendered appropriate responses to the pandemic more challenging. If we plan to emerge from this crisis in a better position, we need a guiding framework on HRH equity that entails indicators with a specific focus on HRH inequities.

A CASE IN POINT OF INEQUITABLE HRH GOVERNANCE

In some U.S. states and federally, mitigating HRH inequities was not a governance priority (13). Since the covid-19 pandemic struck in early 2020, health care providers and patients in all countries had to act fast to alleviate the cumulative impacts of the outbreak (14). The nursing workforce in the U.S. — the largest health professionals group—was rapidly depleted as demands for frontline health workers spiked (15), especially in disadvantaged neighborhoods. Even pre-covid-19, the nursing profession was at an estimated shortage of one million workers (15), chiefly due to a lack of nursing faculty, high turnover, and inequitable distribution of the workforce (16). The actual budget (17) further exacerbated these circumstances by the state's failing to provide sufficient health funding while simultaneously cutting funds for nursing workforce development programs by 64 percent. According to the American Nurses Association, these cuts "essentially dismantled programs that recruit, train, and educate nurses for practice in rural and medically underserved communities" (17). As a result, current health workforce measures include overtime work, delayed annual leave (18), and reactivation of retired health workers throughout the country (19). Moreover, nurse staffing agencies in the U.S. resorted to offering unprecedented incentives for those willing to enter hot zones, including up to $10,000 a week in crisis pay, relocation bonuses, tax-free housing and food (15). Whereas conforming to these extreme measures almost elevated the health workforce to the status of nationwide superstars in the U.S. and worldwide, these measures painfully show that the way out of covid-19 must lead to a path toward equitable HRH.

Furthermore, a misbalance in care access also occurs when the health workforce is inappropriately organized. Health systems lacking a community-oriented (primary) health care system that integrates with public health services face difficulties in meeting individuals' needs while staying-in-shelter as part of an appropriate health response to the virus. In support to the fieldwork of public health specialists, primary health care professionals keep oversight of the differing needs of people at home (20). Meanwhile, clinical specialists are crucial to attend to patients during hospitalization or emergency room visits. Hence, the equitable scaling up of multi-, trans- and inter-professional teams to work in clinics and health centers in the community (such as public health specialists, family practitioners, nurses, clinical specialists, community workers and social workers), will contribute to the most effective difference in the context of health and well-being for all (21, 22).

Some centralized and coordinated strategies come with various advantages, particularly in view of the dangers posed by public health emergencies that transcend borders and local sovereignties (23). First, creating a task force involving all ministries along with all regional and municipal governments helps reach a greater percentage of the population. This would facilitate the containment of a virus. Second, a joined-up

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2https://www.who.int/healthinfo/statistics/toolkit_hss/ EN_PDF_Toolkit_HSS_HumanResources_oct08.pdf?ua=1

strategy and an all-government approach helps extending benefit packages and improve equity of care. If the goal of the country is to reduce health inequities, equitable access to qualified and licensed health workforce ought to be enshrined as a human right by switching toward UHC. Instead of only (re-)acting in crises while cutting budgets in the interim, there is an urgent need for a country's leadership to invest more and continually in HRH equity, as it enhances effective, accessible, equitable and affordable health care for all, and empowers the government to cut down costs of a re-organized and integrated health care system.

THE WAY FORWARD TO HRH EQUITY

We believe that reaching equity in HRH requires close engagement with stakeholders across governments, sectors and communities. It should entail comprehensive and multi-sectoral action at all levels, with implementation and development of accountability and sustainability mechanisms to manage the health workforces' production, stock, skill-mix, distribution, accessibility, productivity and quality (11). Stakeholders must have credible systems to regularly assess evolving population needs, monitor progress on delivery using HRH equity-related indicators, and more importantly, harness the data and findings to evaluate and adjust HRH policies, programs and action plans.

The best health leadership and inclusive governance are only possible if governments start tracking and tracing HRH equity solutions. This applies to both monitoring health progress in the current and post-pandemic situation, as well as addressing long-term HRH inequities. Consequently, public health officials and services partners need granulated, reliable, relevant, and timely data on HRH, enabling a comprehensive overview of the range of health workforce from health sciences, medical and nursing school enrollment numbers to geographical health workforce spread and its impact on social determinants of health. To collect such comprehensive data, tools are needed to help prioritize scarce investigative resources (24). The WHO's National Health Workforce Accounts (NHWA) provides an example that can increase and strengthen such HRH data and ultimately provide the knowledge necessary for countries to improve data availability, quality, standardization and usage (25). While the NHWA and most other tools focus on the health workforce in general, no tools or unified set of indicators specifically focus on HRH inequities. This is partly due to context-bound priorities, which can differ within and between countries, but also due to certain difficulties in defining, measuring, detecting and preventing HRH inequities buried in the public and private policy system. It would therefore be extremely useful if international bodies develop a guiding HRH equity framework, with key concepts, definitions and indicators to support health systems development in the right direction.

While this global pandemic imposed enormous human and economic costs, it equally exposed core issues of health workforce inequity inherent in many current health systems. Health leaders who go forward ought to envision health systems that translate

the lessons learned on health equality and social justice into new forms of knowledge on HRH equities. With other challenges of enormous proportions such as migration and climate change around the corner, the current HRH policies and governance related to their availability, composition, deployment and work quality would need a drastic revision, upgrade, and investment if we want to guarantee dignified lives for all people worldwide.

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CS: conceptualization and writing first draft. All authors: writing final draft.

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COVID-19 Knowledge Test: An Assessment Tool for Health Educators During the COVID-19 Pandemic

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Background: As of August 11, 2020, Coronavirus disease 2019 (COVID-19) has infected 19,936,210 persons and led to 732,499 deaths worldwide. The impact has been immense, and with no vaccine currently available, the best way to protect our communities is health education. We developed a brief COVID-19 knowledge test for health educators that can be used to assess deficits in clients' understanding of the disease.

Methods: COVID-19 Knowledge Test items were developed by the research team and administered to participants. An alternate-choice item format was selected for the knowledge test, and data analysis was based on an American sample of 273 respondents. A detailed analysis of the data was conducted with classical test theory and Rasch analysis.

Findings: The final instrument was found to be a unidimensional measure of COVID-19 knowledge. Results provided evidence for absolute model fit and model fit for individual items. All items included on the scale were monotonically increasing and split-half reliability was considered acceptable. Total test information revealed that the test is suitable for individuals with low to average knowledge of COVID-19.

Interpretation: Rasch analysis provides support for the COVID-19 Knowledge Test to be used as an assessment tool for health educators. The final version of the test consists of 34 high-quality test items that can be administered in <10 min. Normative data and suggested cutoff scores are also provided.

Keywords: COVID-19, knowledge, health education, test, scale development, Rasch analysis

INTRODUCTION

Scientia potentia est, the Latin phrase for knowledge is power, is the public's best defense against COVID-19, and knowledge of the disease is crucial to convincing people to take precautions, such as staying home, physically distancing, and following other preventative measures. According to Van den Broucke (1), health education is only effective in changing behavior when it meets four criteria: (a) Are they susceptible to the condition? (b) Would the condition be severe? (c) Is prevention effective? (d) Lastly, can the preventative actions be performed? With no vaccine currently available, it is essential for health educators

to accurately assess public understanding, and then deliver education where need exists.

Coronavirus disease 2019 (COVID-19) emerged as a cluster of pneumonia cases in December 2019 in Wuhan China, and, as of August 11, 2020, there have been 19,936,210 confirmed cases and 732,499 deaths around the world (2). COVID-19 is highly transmissible. On average, infected individuals have been shown to infect up to three others. Evidence also suggests that asymptomatic people can transmit the virus (3). Additionally, the mortality rate of COVID-19 is significant even among otherwise healthy people and more dangerous to the elderly and other vulnerable populations. The fact that the disease kills otherwise healthy adults, in addition to elderly and other vulnerable populations, is a challenge for health care systems. COVID-19 has had a large impact on mental health (4, 5), and the spread of misinformation can lead to mistrust, panic, and misunderstandings about COVID-19 (6).

Timely public health education is crucial for the prevention of emerging and reemerging infectious diseases (7) and has been previously applied to improve the general population's understanding (8). Individuals with poor knowledge of prevention are less likely to adhere to medical instructions (9). Consequently, continued health education during the COVID-19 pandemic is recommended to ensure people understand the basic facts of the disease and to provide support for people in developing key behaviors to remain healthy.

To help health educators (e.g., physicians, social workers, psychologists, teachers, public health educators) apply effective interventions, we developed a short test that provides an accurate indication of a test taker's general knowledge of COVID-19. The COVID-19 knowledge test could be used prior to a learning intervention to gauge what their clients know and do not know about the current research and facts on COVID-19. Education programs can then be tailored toward various levels of learners instead of using a one size fits all approach.

The COVID-19 knowledge test was found to be a reliable unidimensional instrument that can be administered in under 10 min using Rasch measurement modeling. We incorporated a range of items that could discriminate between test takers with different levels of knowledge by including varying levels of difficulty. Item analysis is an important tool to ensure the quality of a test and to accumulate a bank of well-written items. It is also useful for identifying items that may be too easy or too difficult and that may fail to differentiate between individuals who are highly knowledgeable of COVID-19 and those with little knowledge.

Raw test scores can lead to errors in analyses when comparing test takers. An educator may be inclined to sum raw scores, but it is unlikely that all test items are equally difficult. Comparing test takers based on totaling raw scores does not provide meaningful and accurate comparisons of knowledge between test takers. Thus, we used the Rasch measurement model to compute respondent performances in a meaningful way. Rasch measurement allows the meaning of a test to be explained in terms of the test's items, allowing test administrators to use raw test scores to explain test taker performance on a linear scale that accounts for unequal difficulties across all the test items (10).

METHOD

Ethics approval for this study was provided by New York University's Institutional Review Board (HRPP-2020-69). Participants were drawn from Mechanical Turk (MTurk), a crowdsourcing internet site that permits people to complete surveys for nominal compensation. Participants were identified by a unique identification number. MTurk qualification filters were specified to only include American participants with a minimum of a 90% positive rating on previous MTurk tasks.

Three hundred and forty-two responses were initially received. After data screening, 273 responses remained. Participants were removed if they did not respond as expected to the attention check items or if they did not complete more than 75% of the questions. The mean age of participants was 40.06 (SD = 13.15) years. One hundred and fifty-two men and 119 women participated in the study. The racial distribution included 218 Caucasians, 22 blacks, 21 Asians, one Native American, and 12 who identified as biracial or other race.

About 1% of participants reported they did not have a high school diploma, 7% had a high school diploma or GED, 13.9% reported they had some college but no diploma, 7% had an associate degree, 45% had an associate or undergraduate degree, and 25% had a graduate degree. The majority of participants' primary source of knowledge about COVID-19 was the internet (61.2%) and television (32.6%). Less than 1% of participants' primary sources of knowledge were friends, family members, medical journals, and work.

MATERIAL

Item Development

Forty-nine items were developed to tap basic knowledge of COVID-19 through consulting peer-reviewed journals and reputable websites (e.g., the World Health Organization, The Lancet, Microbiology, and Infection). Initial item content consisted of medical terminology related to COVID-19, symptoms of the virus, a brief history of corona viruses, risk factors, and pertinent findings from emerging research. Once the items were developed content validity was reviewed by a three-person expert panel (two physicians and a doctoral educated panel member in biochemistry) and revised accordingly.

Alternate-choice item format was selected instead of true or false or multiple-choice, because it offers a comparison between two choices. One of the advantages of the alternate-choice format is that more questions can be asked in a testing period, which can create a more reliable test than multiple-choice format (11, 12). Further, alternate-choice tests have been found to exhibit satisfactory psychometric properties in previous research (13–16).

Attention Items

In addition to participants answering basic items that tapped their knowledge of COVID-19, they were asked three questions to confirm they were paying attention. The attention check items were adapted from the SPECTRA Indices of Pathology Scale's Infrequency Scale (17) and were as follows: "I have difficulty

remembering if I went to elementary school," "I have never seen a dog," and "I am answering these questions truthfully."

RESULTS

Classical test theory (CTT) analysis was conducted first using the item.exam (data, discrim = TRUE) command in the psychometric library in the R software for statistical computing. An initial review of the 49 items revealed that items C3, C15, and C18 had negative discrimination values and were therefore deleted. Items with negative discrimination indices are problematic because they indicate that high-performing participants tend to provide incorrect responses and low-performing participants provide correct responses (18).

Following CTT analysis, item response theory (IRT) analyses were completed for the remaining items. The assumption of unidimensionality was first assessed using the mirt library, which was developed to estimate multidimensional item response theory parameters in R (19). According to Hattie (20), spurious factors can occur in exploratory factor analysis with dichotomous item response data, which can lead to errors and incorrect conclusions about the dimensionality of data. Instead, exploratory factor analysis models are specified using the information maximum likelihood expectation maximization (EM) algorithm of Bock and Aitken (21).

One- and two-factor exploratory factor analysis (EFA) models were first specified. The statistically significant results ($p < 0.05$) of the likelihood ratio test, along with the values for the Akaike information criterion (AIC) information index, indicated that a two-factor model (AIC = 11408.45) fit the data better than a one-factor model (AIC = 11399.62).

Since the assumption of unidimensionality was initially violated, the multidimensionality of the data was further explored through examining the factor loadings of the factor analysis. Items C5, C7, C9, C13, C14, C16, and C23 were deleted because they were loading on a second factor. The models were tested again, and the one-factor model fit the data better than the two-factor model.

To assess the assumption of monotonicity, the Rasch measurement model was applied. The data were fit to the model setting the item discrimination parameter value to equal one for all items. This allowed us to differentiate among examinees with different levels of knowledge of COVID-19. The data did not meet the assumption of monotonicity for item C17 because the relationship between the latent trait and probability of item endorsement was not monotonically increasing. Consequently, this item was deleted.

To test whether the model fit for the individual items, the item.fit (test.rasch, simulate.p.value = TRUE) command was used. Significant results for item fit indicated the model did not accurately fit the responses for each item (22). The model fit for the individual items, except for items C8, C20, C38, and C46, which were significant at the 0.01 level; thus, these items were also removed. Further, absolute model fit was assessed using a bootstrap model of fit test with the GoF.rasch (test.rasch, B = 1,000) command. The results were not significant (p =

TABLE 1 | Factor loadings for the 34-item knowledge test.

Item	F1
C1	0.49
C2	0.26
C4	0.22
C6	0.60
C10	0.72
C11	0.58
C12	0.43
C19	0.36
C21	0.47
C22	0.26
C24	0.46
C25	0.47
C26	0.62
C27	0.03
C28	0.54
C29	0.61
C30	0.49
C31	0.58
C32	0.27
C33	0.05
C34	0.59
C35	0.31
C36	0.16
C37	0.45
C39	0.87
C40	0.55
C41	0.57
C42	0.42
C43	0.19
C44	0.35
C45	0.79
C47	0.75
C48	0.60
C49	0.27

Oblimin rotation using the information maximum likelihood expectation maximization (EM) algorithm.

0.22), demonstrating that the Rasch model adequately fit the data. Unidimensionality was assessed for a final time. The factor loadings can be found in **Table 1**, and the comparison of factor models can be found in **Table 2**.

The sum of squared loadings for the model was 8.34, and the proportion of variance in the observed variables associated with the one factor accounted for 24.5% of the variance present in the items. Consequently, we can conclude that the assumption of unidimensionality was met for the 34-item knowledge test and that one factor underlies the responses to the knowledge items.

In order to precisely estimate item difficulty, the Rasch model was applied again. The data were fit to the model with the item-discrimination parameter value set to equal one for all items. Item difficulty values for the knowledge test ranged

TABLE 2 | Comparison of factor models.

Factors	AIC	AICc	SABIC	HQ	BIC
1	8279.493	8325.493	8309.326	8378.02	8524.938
2	8285.559	8406.050	8329.870	8431.899	8650.116
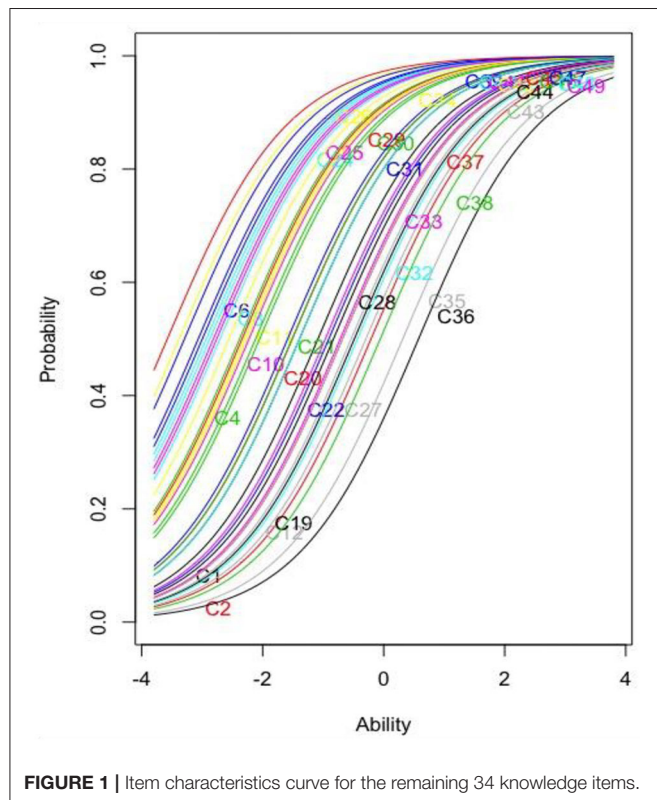
FIGURE 1 | Item characteristics curve for the remaining 34 knowledge items.

TABLE 3 | Item difficulty values, standard error, and Z-values.

Item	b-values	std.err	z.vals
C1	−1.09	0.16	−7.01
C2	−0.21	0.14	−1.49
C4	−2.39	0.21	−11.24
C6	−3.00	0.26	−11.39
C10	−2.23	0.20	−11.02
C11	−2.27	0.20	−11.08
C12	−0.54	0.15	−3.71
C19	−0.49	0.15	−3.36
C21	−1.52	0.17	−9.01
C22	−0.91	0.15	−6.01
C24	−2.88	0.25	−11.44
C25	−2.82	0.25	−11.45
C26	−3.38	0.31	−11.03
C27	−0.30	0.14	−2.07
C28	−0.84	0.15	−5.55
C29	−2.35	0.21	−11.19
C30	−2.12	0.20	−10.83
C31	−1.59	0.17	−9.30
C32	−0.44	0.15	−3.01
C33	−0.72	0.15	−4.87
C34	−2.56	0.23	−11.39
C35	0.31	0.14	2.17
C36	0.57	0.15	3.91
C37	−0.69	0.15	−4.64
C39	−3.30	0.30	−11.14
C40	−2.94	0.26	−11.42
C41	−2.76	0.24	−11.45
C42	−2.31	0.21	−11.14
C43	−0.69	0.15	−4.64
C44	−1.40	0.16	−8.50
C45	−3.58	0.33	−10.76
C47	−3.07	0.27	−11.35
C48	−1.40	0.16	−8.50
C49	−0.97	0.15	−6.35

Akaike information criterion (AIC) = 8366.981, Bayesian information criterion = 8489.703, and log-likelihood value (logLik) = −4149.491.

between −3.58 and 0.57. Item difficulty is the point on the item characteristic curve where the S-shaped curve has the steepest slope. Examinees must have greater knowledge to answer a difficult item correctly. Less knowledgeable test takers are likely to answer items incorrectly, with values >1.00, whereas examinees with less knowledge will have a moderate chance of answering items with values <-1.00 correctly. Item difficulty values between −1.00 and 1.00 are considered moderately difficult; items <-1.00 are easy, and items >1.00 are difficult (23). Thirteen of the knowledge-test items were moderately difficult and the remaining 21 items were easy. Split-half reliability was computed with Kuder–Richardson Formula 20 (KR-20). KR-20 was 0.70, demonstrating an acceptable level of internal consistency (24).

Figure 1 presents the item characteristic curves for the remaining 34 items. The vertical axis displays the probability of success of a person on each item, ranging from 0.00 to 1.00. The horizontal axis displays a person's ability in log-odd units. When item difficulty and person ability are matched, the test taker has a 50% chance of success on that item (i.e., 50/50 odds). Item C2 is the closest item to 0.00 logits. Difficulty values for the remaining items can be found in **Table 3**. In addition, item z-values for the

knowledge test items were all greater than two; z-values greater than two indicate that the item parameter is unlikely to be zero in the population (22).

Figure 1 demonstrates the relationship between knowledge of COVID-19 and the probability of a correct response monotonically increases for the 34 knowledge items. This means that the more knowledge people have about COVID-19, the greater the probability of correctly answering an item. Relative difficulty can also be examined based on location in the graph. For example, item C45 is the easiest item because it is furthest to the left of the y-axis, while item C36 is the most difficult item since it is the furthest to the right.

The total test information curve (see **Figure 2**) demonstrates that maximum information for examinees was approximately

FIGURE 2 | Total test information curve for the 34-item knowledge test.

TABLE 4 | Demographic variables, scores, means, and standard deviations for the knowledge test.

Variable	Characteristic	N	Mean	SD
Sex	Male	152	25.84	4.31
	Female	119	26.85	3.60
Age	18–29	54	24.80	4.96
	30–39	105	25.83	4.13
	40–49	42	26.57	3.29
	50–59	46	27.98	2.41
	60+	26	27.62	3.80
Race	White	218	26.59	3.91
	Black	22	24.14	3.54
	Native American	1	20.00	0.00
	Asian	21	25.52	5.33
	Biracial	5	27.60	1.82
	Other	7	25.20	5.17
Education	<Grade 12	2	19.00	4.24
	High school graduate	19	25.63	4.18
	Some college	38	26.76	3.12
	Associate degree	18	26.44	3.55
	University degree	123	26.28	4.32
	Graduate	70	26.63	3.81
Learning source	Internet	167	26.40	3.92
	Television	89	26.02	4.34
	Newspaper	8	24.50	3.16
	Friends	3	28.00	2.65
	Family	2	22.50	2.12
	Medical journals	3	31.00	1.73
	Work sources	1	30.00	0.00

−1.6 or slightly below average knowledge of COVID-19. Hence, this a good scale for discriminating between test takers who score in the −3.0 to +1.5 standard deviation range (i.e., very low when compared with average scores).

To understand the amount of information this instrument will provide for those with above average knowledge of COVID-19, a numeric estimate was obtained using the information (test.rasch, c[0,10]) command in R. In the above average range of knowledge, the total information yielded by the knowledge test was 33.99 or 20.96% of the total information provided by the Rasch measurement model. About 79.04% of the information is provided for knowledge levels below zero. Final item statistics can be reviewed in **Table 3**.

The total mean score for the remaining items was 26.27 (SD = 4.05). Based on a standard deviation of 4.05, scores below 21 are below average, scores between 22 and 29 are average, and scores 31 and higher are above average for this sample. **Table 4** provides distributions of total score on the knowledge test by demographics. Overall, 15% of participants had a score below average, 64% of participants had average scores, and 21% had above average scores. The final knowledge test items and answers can be found in the **Supplementary Material**.

DISCUSSION

A successful response to COVID-19 requires people around the world to understand evolving messages from governments and health authorities in order to protect themselves from infection and prevent disease spread. Government messaging has led to misunderstanding about the danger of COVID-19 (25), creating confusion and inaction (26). We developed a norm-referenced

measure that can be used by health educators and researchers to better understand a layperson's knowledge of COVID-19 prior to the delivery of a health education program. If educators can interrupt and eliminate errors and misinformation, preventative measures will be more successful in reducing the spread of the virus.

The COVID-19 Knowledge Test assesses relevant medical terminology that has been cited in the news and in scientific journals. It includes questions concerning symptoms of the virus, relevant scientific discoveries, and pertinent findings that affect the safety of the general public. The test consists of 34 items that can be completed in <10 min. It also includes normative data that can be used by health educators to assess their clients' understanding of the disease.

We found strong evidence that the COVID-19 Knowledge Test is a unidimensional measure with acceptable split-half reliability. Analysis of the Rasch measurement model found that the test items range from easy to moderately difficult, and the total test information curve indicated that this is a good scale for discriminating between exceptionally low and average scores. Educators and researchers may use this test to make meaningful assessments of test takers' knowledge.

A limiting factor for this study was the span of available knowledge being spread on mainstream news channels and

websites about COVID-19 due to the pandemic itself, possibly inflating normative data for this test. In the years ahead, it would be paramount to determine how much people learn about this disease and how prepared they are in the event of future outbreaks. A second limitation of the study is that some of the questions rely on current research. A year from now, those questions will need to be revised or deleted if the scientific knowledge of the diseases has changed. Future research is recommended to investigate the construct validity of the COVID-19 Knowledge Test in comparison with other health measures (e.g., 15-Item Health Knowledge Test) and to continue to develop normative data with a variety of groups.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by New York University's Institutional Review Board.

The participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

LR collected the data, processed the statistical data, and drafted the manuscript. JB revised the final manuscript, finalized ethics approval, and assisted in summarizing the findings. All authors contributed to the article and approved the submitted version.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpubh.2020.580204/full#supplementary-material

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Impact of SARS-CoV-2 on Provided Healthcare. Evidence From the Emergency Phase in Italy

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The SARS-CoV-2 (COVID-19) pandemic led to an emergency scenario within all aspects of health care, determining reduction in resources for the treatment of other diseases. A literature review was conducted to identify published evidence, from 1 March to 1 June 2020, regarding the impact of COVID-19 on the care provided to patients affected by other diseases. The research is limited to the Italian NHS. The aim is to provide a snapshot of the COVID-19 impact on the NHS and collect useful elements to improve Italian response models. Data available for oncology and cardiology are reported. National surveys, retrospective analyses, and single-hospital evidence are available. We summarized evidence, keeping in mind the entire clinical pathway, from clinical need to access to care to outcomes. Since the beginning, the COVID-19 pandemic was associated with a reduced access to inpatient (−48% for IMA) and outpatient services, with a lower volume of elective surgical procedures (in oncology, from 3.8 to 2.6 median number of procedures/week). Telehealth may plays a key role in this, particularly in oncology. While, for cardiology, evidence on health outcome is already available, in terms of increased fatality rates (for STEMI: 13.7 vs. 4.1%). To better understand the impact of COVID-19 on the health of the population, a broader perspective should be taken. Reasons for reduced access to care must be investigated. Patients fears, misleading communication campaigns, re-arranged clinical pathways could had played a role. In addition, impact on other the status of other patients should be mitigated.

Keywords: COVID-19, SARS-CoV2, cancer care, cardiology, Health Services Research, Response model (RM)

INTRODUCTION

The first autochthonous confirmed case of SARS-CoV-2 (Severe Acute Respiratory Syndrome Coronavirus 2) was registered in Italy on 21 February 2020 in Codogno (Lombardy), generating the first relevant outbreak of the virus. The Italian government ordered a nationwide lockdown, which was effective starting 9 March 2020, while the World Health Organization (WHO) declared COVID-19 a pandemic on 11 March.

At the time this was written, Italy has counted more than 243,000 confirmed cases of COVID-19 and a cumulative number, >195,000, COVID-19 discharged patients. At the peak of the first phase of the emergency, saturation in ICUs reached 54.9 % (1).

Therefore, on addition to promoting measures that limited the transmission of the disease, in-hospital clinical activities had to rapidly adapt their methods of organization to the healthcare

emergency. The reduction, or even interruption, of non-COVID related activities were the main solutions suggested to all Regional Health Authorities by the Ministry of Health, with guidelines for the re-organization of services issued on 16 March 2020 (2). Furthermore, prioritization criteria were defined for access to critical services, such as surgical procedures requiring a longer stay in intensive care.

The Graduate School of Health Economics and Management (ALTEMS) has been monitoring the response of the Italian NHS since the beginning of the emergency with a weekly Instant Report (3). The aim is to provide an integrated analysis of available data on COVID-19. The major goals are to identify differences and analogies among national and regional COVID-19 models of care and anticipate short and long term needs. Due to this, since end of May 2020, a specific section is dedicated to the collection and analysis of data regarding the impact of COVID-19 on the care provided to other patients.

During the first phase of the emergency, resources were focused on dealing with the COVID-19 impact on human and organizational resources of the NHS and on making the emergency sustainable. ALTEMS estimated a reduction of more than 860,000 hospital discharges during the COVID-19 outbreak, on the basis of a simulation that took into account hospital discharge data in 2018. During this period, hospital activity was limited to urgent treatments, and we have estimated that more than 520,000 surgeries were not performed during a 4 months period (3) (Instant Report # 9). At the beginning of the so-called Phase 2, it was time to find a new equilibrium between new and "old" healthcare needs. The NHS had to provide assistance both to COVID-19 patients but also to patients affected by other diseases whose needs were put on a sort of waiting list from February until May 2020. In order to better describe this additional burden of care and the consequence of the temporary reorganization of the NHS, the Altems working group is conducting a literature review focused on published studies for the Italian context.

METHODS

A realist literature review (4) was adopted due to the fast evolving scenario. It was conducted to address the following questions: (a) How did the COVID-19 pandemic impact on the care provided to other patients (e.g., patients with non-COVID related clinical conditions) in Italy?; (b) How does it impact on different specialities and level of care in the Italian NHS?; (c) What are the implications in the organization of the NHS at national, regional, and local levels?

The search strategy and keywords were organized around the following three broad realist concepts:

- Context: the activity of the Italian NHS during the emergency phase (from mid-February 2020 to June 2020) of the COVID-19 pandemic;
- Clinical areas: a step-by-step approach was adopted. The research first focused on cardiology and oncology. It will then be extended to transplantation, gastroenterology, nephrology,

and so on. The choice of these two areas was pragmatic and based on first available evidence and different levels of care and need involved. For instance, our analysis will provide input on how COVID-19 impacts the ability of the NHS both in responding to urgent need (due to cardiovascular emergencies), as well as providing elective surgical procedures and outpatient care (to cancer patients);
- Impact: healthcare service usage data, measurable health outcomes, and NHS organization is the main focus. Despite the fact that the majority of evidence comes from healthcare providers, it was decided, when available, to include patient perspectives.

At the end of May 2020, a search was conducted on Pubmed, websites of major Italian medical associations, and national medical news websites (such as: Quotidiano Sanità, Il Sole24Ore Sanità, and so on).

All English and Italian language papers published on scientific journals or studies from which reports were published online on reliable websites from February 2020 until the end of May 2020 were included in our review.

RESULTS

Selected Papers

A total of 20 studies were selected: five provided data on cardiology, while 15 referred to oncology in Italy. As shown in **Table 1**, studies on the impact of COVID-19 in cardiology mainly focus on coronary syndrome (ACS). The distribution of studies among NHS levels (national, regional, hospital) is similar for the two clinical areas. Eight out of 20 studies have been performed on the basis of data collected on a national level. Six of the eight studies with a national perspective were in the area of oncology. One of them (5) provided data on hospital admissions for acute coronary syndrome (ACS) in five (out of 21) regions. It was considered representative given the COVID incidence in those regions.

The majority of studies are based on surveys. Data cover the February-March 2020 period, and efforts were made to compare the 2020 scenario with previous years. Only two studies (12, 14) are based on a national survey performed in April 2020.

Selected papers collected data on clinical and/or organizational variables and some of them even on patient perspective. As showed by **Figure 1** studies on oncology pay more attention to organizational variables compared to studies on cardiology. While health outcomes, such as mortality, are already available for cardiovascular emergencies (**Table 1**), the link between hospital re-organization and provision and access to care is investigated more thoroughly for cancer care. For instance, two different surveys on oncology (12, 13) reported how the reduction of available beds (acute and in intensive care) impacted on clinical volumes, surgical procedures, outpatient services, radiation therapy, and so on. In oncology, the first evidence on how telemedicine helped guarantee continuity of care is available (17, 20). In **Supplementary Materials**, more

TABLE 1 | Selected studies on cardiology and oncology.

References	NHS level	Details	Location	Primary outcome (or focus)	Study designed	Covered period	Sample size
Cardiology							
De Rosa et al. (6)	National	54 centers	Italy	Patients with AMI admitted to intensive cardiac care units	Online survey open to affiliates of the Italian Society of Cardiology	12–19 March 2019 vs. 2020	937 AMI patients
De Filippo et al. (5)	Multicentre	15 centers located in 5 Regions	Piedmont, Liguria, Lombardy, Emilia Romagna, Lazio	Hospital admissions for ACS	Retrospective analysis	1 January to 19 February + 20 February to 31 March 2019 vs. 2020	2202 ACS patients
Piccolo et al. (7)	Regional	20 PCI centers	Campania	Rates of Percutaneous Coronary Revascularization for Acute Coronary Syndromes	Retrospective analysis	30 January to 26 March, 2020	1,831 PCIs
Cosentino et al. (8)	Hospital		Lombardy	In-hospital pathway for Acute Coronary Syndrome patients	Retrospective analysis	13 March to 9 April, 2020	92 ACS patients
Mazzone et al. (9)	Hospital		Lombardy	Re-organization of a referral center for cardiac electrophysiology (EP)	Retrospective analysis	October–December 2019 vs. January–February 2020 vs. March 2020	
Oncology							
Costantini et al. (10)	National	Hospices	Italy	Preparedness for and impact of the COVID-19 pandemic on hospices	Cross-sectional telephone survey	Administered between 11–15 March, 2000	16 Hospices
Indini et al. (11)	National	Head physicians *via* hospital medical oncology ward -Oncologi Medici Ospedalieri (CIPOMO)	Italy	COVID-19 containment measures and diffusion in oncology units and its impact on working activities	Survey	Administered between 12–15 March, 2000	122 Head physicians
Jereczek-Fossa et al. (12)	National	125 Directors from Italian radiation oncology wards, members of the AIRO	Italy	Clinical and outpatient activities, patients and staff management during COVID-19 emergency	Survey	Administered between 6 and 16 April, 2020	125 directors
Torzilli et al. (13)	National	Referral centers for HPB, colorectal, esophago-gastric, and sarcoma/soft-tissue tumors	Italy	Elective oncology surgery	Survey	Before vs. entire period (5 weeks, starting 18 February), and during the week (23–27 March, 2020)	54 referral centers
Progetto (14)	National		Italy	Diagnosis, treatment, and follow-up activity during COVID-19 pandemic	Survey	Administered between 14 and 29 April, 2020	774 patients
Lambertini et al. (15)	National	Perspectives of young oncologists	Italy	Practical suggestions on how to implement cancer care during the COVID-19 outbreak	Editorial		
Casanova et al. (16)	Hospital/ Outpatient care	Patients from a Pediatric oncology unit	Lombardy	Patient perception of COVID-19 epidemic	Survey	Administered between 2 and 5 March, 2000	25 patients were receiving treatment; 25 patients were in follow-up, who had completed their treatment; 25 were healthy peers

(Continued)

TABLE 1 | Continued

References	NHS level	Details	Location	Primary outcome (or focus)	Study designed	Covered period	Sample size
Brandes et al. (17)	Regional	Oncology wards	Emilia-Romagna	Patients, healthcare workers, risk-reduction measures, and clinical trials	Survey		12 oncology wards
Campi et al. (18)	Hospitals	3 High-volume academic centers for major uro-oncologic surgery	Piedmont, Lombardy, Tuscany	Classification as high priority, major uro-oncologic surgical procedures	Retrospective analysis	12-mo period (2018 or 2019)	2,387 patients
Balduzzi et al. (19)	Hospital	1 Pediatric transplant and haemato-oncology center	Lombardy	Preventive and control measures	Case study		
Bongiovanni et al. (20)	Hospital	1 Osteo-oncology and rare tumor center	Emilia-Romagna	Report of a multidisciplinary approach	Case study	9 March—17 April, 2000	3,348 screened patients (3% with BM)
Kengli et al. (21)	Hospital	1 Radiation oncology ward	Piedmont	Preventive measures and recommendations	Case study		
Vicini et al. (22)	Hospital	1 Division of breast surgery in a cancer hub center	Lombardy	1st month experience/impact	Case study	March 2020	
Montesi et al. (23)	Hospital	1 Radiation oncology unit	Veneto		Case study	1 February—31 March, 2020	
Pezzulla et al. (24)	Hospital	1 Radiotherapy oncology unit	Molise	Measures to minimize the risk of infection among operators	Case study		
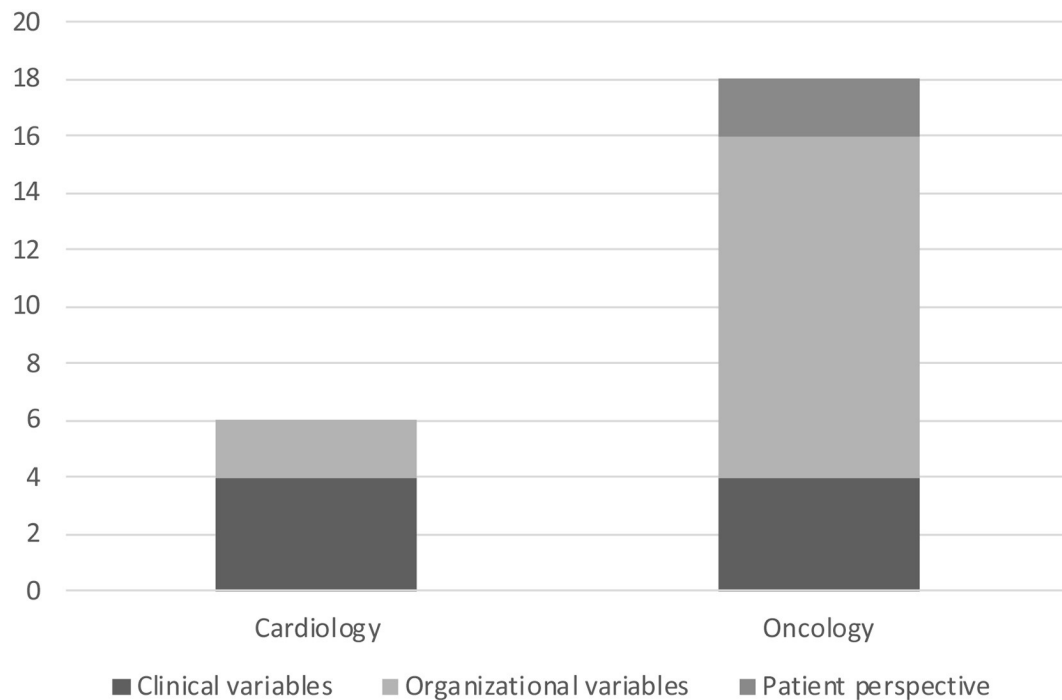
FIGURE 1 | Variables investigated by selected studies.

details are reported on variables/endpoints for which data was collected in selected studies.

Patient perspectives were only investigated in oncology, with two different surveys: the first (16) was limited to adolescent and young adult patients from a pediatric oncology unit in Lombardy, and the other was (14) on a national level. The latter survey, which included 774 responders (**Table 1**), had the objective of collecting evidence on the impact of the COVID-19 pandemic regarding access to care, from diagnosis to follow up, while the first was based on a total of 75 responders (**Supplementary Materials—Table A1**) and was more focused on the perception of the risk associated with the outbreak of COVID-19.

Available Evidence

Table 2 aims to summarize the major consequences of the COVID-19 outbreak on the ability of the NHS to manage cardiologic and oncologic patients. From volumes of activities to continuity of care, the significant negative impact of the pandemic on the operativity of the NHS is clear despite all the initiatives taken at different levels of the NHS.

New clinical pathways were adopted to guarantee patient and personnel safety. At the same time, the optimization of hospital resources (not only ICU beds), and the need to have COVID-19 dedicated personnel, led to a contraction in activities. For instance, 30.4% of oncology centers reported a contraction of their activities of 10–30% (13). The reduction in cardiology was more significant, even for urgent cases, such as AMI patients (48.4% reduction in hospital admissions for AMI).

While initial negative results, in terms of health outcomes, are already available for cardiology, we just registered a clinical relevant reduction in the assistance provide along the entire clinical pathway in oncology.

DISCUSSIONS

The COVID-19 outbreak has direct and indirect effects on the healthcare delivery process in the Italian NHS. At national, regional, and local levels, the Italian NHS re-engineered its clinical processes, in order to manage COVID patients, both in hospitals and at home. Nevertheless, the pandemic affected healthcare delivery for non-COVID patients. Our effort was to further emphasize how the COVID-19 emergency had implications for non-COVID patients, along the entire process of care in different settings (hospitals, outpatient services, hospices). Our approach was quite similar to that proposed by Richards et al. (25) to identify all implications on patient pathways in oncology. We collected available data for Italy on COVID-19 implications for diagnosis, surgery, treatment, continuity of care, and research for different clinical areas, as suggested in (25). Our literature review was the first step toward an in-depth analysis of how the healthcare policy implemented (explicitly and implicitly) during the emergency translated into organizational choices adopted at national, regional, and local levels and how it determined short and long term health outcomes.

Based on available data, the re-organization of hospital logistics and clinical activities, during the first phase of the emergency, determined a reduction in inpatient and outpatient services provided to non-COVID patients. In addition, communication activities on the risk of COVID-19 transmission could have contributed to a lower propensity by patients to directly refer to hospitals.

In cardiology, a new organization of the NHS and also patient fears could both explain the lower rate of hospital admission for IMA and ACS (5, 6) and the associated higher case fatality and complication rates, due to a delay in access to care and in diagnosis. The lower number of percutaneous coronary interventions (PCI), especially in women, needs special attention.

In oncology, the reduction of available acute and intensive care beds translated in a lower amount of surgical procedures and was associated with a reduction of outpatient activities. A reported reduction of the overall activity of 10–30% in a third of cancer centers (12) is confirmed by patients. In fact, 36% of those interviewed reported postponement or cancellation of clinical exams and follow up visits (14). The impact of hospital reorganization regarding access to clinical and diagnostic exams, such as CT scans, MRIs, and so on, is not secondary. Even if only one paper (13) provided some evidence on that point, it is a critical step along a clinical pathway.

Both for cardiology and oncology, only short term activity and health outcome data can be already available. In addition, even if some national surveys were conducted, generalizability of provided data must be proven and more detailed data collected. Studies should be extended in time, in order to collect real world evidence (RWE) on the long-term consequences of the COVID-19 outbreak on patients affected by other diseases.

However, available studies already provide useful and relevant results toward planning the new Italian NHS out of the first phase of the emergency. First of all, a better communication approach should be adopted so that patients in critical conditions do not avoid seeking medical attention, therefore, putting their lives at risk, as data in cardiology has already demonstrated. Furthermore, campaigns that aim to increase awareness of critical symptoms, even during emergencies, should not play a secondary role (7), as suggested in the analysis conducted on PCI centers in Campania.

As different approaches (hospital-based, territorial-based, or combined models) were taken by the Italian health system in order to respond to the COVID-19 emergency (3, 26), meanwhile, alternative organizational initiatives have been adopted to manage non-COVID patients. These alternative organizational solutions should be further investigated to support the NHS out of the seemingly less critical phase. Once our literature review is completed, an analysis of organizational models will be conducted covering the most relevant areas for the Italian "Core Benefit Package of Healthcare Services" (so called LEA—Livelli Essenziali di Assistenza). This kind of analysis will be necessary, in order to redefine the capacity and priorities of NHS in recuperating "unprovided care"

TABLE 2 | Impact of COVID-19 on cardiology and oncology care in Italy.

	Cardiology	Oncology	References
Volume of activity			
Overall		*At national level:* In 30.4% of centers, a 10–30% reduction was reported.	(6, 12)
Outpatient		*At national level:* Patients report postponement of follow-up visits (36%). One patient out of five reported cancelation of diagnostic exams.	(14)
Inpatient	*At national level:* 48.4% (95% CI 44.6–52.5) reduction in admissions for AMI.		
Surgical procedures	*At regional level:* 32% decline in the number of PCI for ACS (incidence rate from 178 to 120 cases/100,000 residents).	*At national level*: Number of surgical procedures decreased (median number of 3.8 [IQR 2.7–5.4], per week before COVID-19 emergency, to 2.6 [22–4.4] later).	(7, 13)
Diagnostic exams		*At national level*: Reported limited access to the following hospital facilities: CT in 31% of cases, MRI in 24%, (PET)-CT in 13%, endoscopy in 26%, percutaneous procedures in 20%, endovascular procedures in 15%, and radiotherapy in 11%.	(13)
Clinical outcomes			
Mortality	*At national level:* An increase in STEMI case fatality rate [13.7 vs. 4.1% (RR =3.3, 95% CI 1.7–6.6; *P* < 0.001)].		(6)
Complications	*At national level:* An increase in STEMI (RR = 1.8, 95% CI 1.1–2.8; *P* = 0.025) and nSTEMI (RR =2.1, 95% CI 1.05–4.1; *P* = 0.037) patients with major complication.		(6)
Timing			
Access to care	*At national level:* 39.2% increase in the time from symptom onset to coronary angiography—AND.	*At regional level:* Follow-up visits were canceled in 16.7% of centers, delayed in 58.3% of centers, and performed by remote assessment in 58.3% medical oncology wards.	(6, 17)
Waiting list	*At national level:* 31.5% increase in the time from first medical contact to coronary revascularization.	*At national level:* In most facilities *(62.4%),* rescheduling of patient waiting lists (prioritization) was also carried out. Most units (87%) expected to have a median prolongation of 4 weeks in the time interval between the pre-operative multidisciplinary meeting and surgery.	(6, 12)
Continuity of care			
Telemedicine		*At national level:* To guarantee the continuity of care, telematic consultations were activated in 78 centers (62.4%).	(13)
		At regional level: For a defined group of patients (patients with bone metastases), telemedicine helped in guaranteeing continuity of care and a multidisciplinary approach from first diagnosis to pain management.	(20)
Research activities			
Clinical trials		*At regional level:* 66.7% of medical oncology wards suspended accruals of clinical trials.	(17)
Available resources			
Beds	*At hospital level:* Internal strategies were adopted for sparing both ICU beds and anesthesiology personnel.	*At national level:* 76% of centers had a reduction in their surgical activity (days of operating room); 83% had less availability of ICU beds; 52 (96%) had a reduction in outpatient clinics.	(9, 13)
Human		*At national level:* > 30% of oncologic structures had to employ their oncologists for guard duties in internal medicine and/or emergency wards; in 23% of cases, guard duties in COVID wards were included.	(11)
		At national level: Physicians and RT technicians were most frequently COVID-19 infected, followed by nurses, medical physicists, and other personnel.	(12)
		At regional level: COVID-19 infection was diagnosed in 10.1% medical doctors, 5.7% nurses, 11.8% social care workers.	(17)
Internal organization			
Hospital	*At hospital level:* Some evidence is available on the adoption of a hub-and-spoke model for cardiology. However, only urgent and non-deferrable procedures were performed.	*At national level:* 85 structures (68%) became COVID-19 centers, requiring an immediate reorganization of the entire facility.	(9, 13)
Ward	*At hospital level:* New, in-hospital pathways for ACS were adopted to guarantee the best and safest treatment for all patients.	*At national level:* 37.5% of RT wards/DHs were converted into COVID-19 centers.	(8, 13)

during the COVID-19 outbreak. Additional factors to consider will be NHS decentralization and regional variability, as well as pre-existing horizontal fragmentation and continuity of care (27).

Some data is available both in cardiology (**Table 1**) and oncology (**Table 2**) on how single hospitals adapt their technological and human resources to the emergency and related preliminary results. In particular, preliminary data in cardiology were collected on how a hub-and-spoke model performed in Lombardy (9, 22). While, for oncology, a national survey (13) collected preliminary evidence on the activation (only in 19% of the 29 planned cases) and efficiency of oncology hub-and-spoke programs during the emergency. Only one study (18) simulated how recommendations for prioritizing urologic surgeries could impact the activity of high-volume academic centers. Effectiveness of models of care, internal hospital protocols, and prioritization criteria should be investigated, taking into consideration the local diffusion and evolution of COVID-19.

Ongoing telemedicine initiatives, which are promising in some local experiences (17, 20), require a better coordinated approach and clearer guidelines. In its weekly Instant Report dedicated to COVID-19, ALTEMS dedicated a special section to digital health solutions adopted at regional and local levels to support healthcare services and deal with the COVID-19 outbreak.

Our analysis did not focus on clinical research, but several preliminary data on delays and restrictions in clinical trials are available (17). Pragmatic steps to minimize impact on trials, as suggested in (25), had been taken. Remote management of treatments, remote meeting with other centers and delivery of treatment directly to patients or pharmacy were solutions adopted in Emilia Romagna (17).

Finally, healthcare professionals remain a key resource for the NHS. The COVID-19 outbreak determined an additional workload for them, including crisis unit meetings (19), the need to learn new and different skills in the case of COVID-dedicated staff, the need to adapt a new organization in a short timeframe, the need to learn new ways to provide assistance (e.g., telemedicine, remote multidisciplinary meetings) (20), and so on. Associated with this was a shortage of specific profiles, such as intensivists. In addition, exposure to COVID-19 was and is a serious professional risk (28), as is demonstrated by the more than 29,000 positive COVID-19 cases among healthcare professionals and more than 160 and 40 deaths among clinicians and nurses, respectively, on a national level. In Torzilli et al. (13) was reported that in 33% of the departments for oncological surgery, which responded to the survey, at least one surgeon became COVID+. They represented up to 38% of the working power of the teams. While according to the survey conducted by the Italian Association of Radiotherapy and Clinical Oncology (AIRO) (12), 45% of centers had more than one staff persons in quarantine and 8.8% of centers had more than 5 units off.

CONCLUSIONS

The SARS-CoV-2 (COVID-19) pandemic produced a dramatic impact in terms of deaths. But the actual impact on the health status of the population can only be measured if we look at it from a broader perspective. The reduction in the accessibility of non-COVID patients to healthcare services is a side effect of the COVID-19 outbreak, having a potential impact on the health of the population in the short and long term. Our paper has shed light on the short-term, and the indirect impact of COVID-19 for oncologic and cardiologic patients in Italy. The results of our literature review suggest that the emergency has reduced the accessibility of patients to hospitals and other healthcare services, and that it is already possible to identify a negative effect on clinical outcomes.

This evidence has implications for regional and national health policies and planning. In other words, the COVID-19 outbreak has reduced the capacity of the NHS to ensure the "Core Benefit Package of Healthcare Services" (so called LEA—Livelli Essenziali di Assistenza) that, by legislation, should be provided via healthcare organizations under the coordination of 21 Regional Health Authorities.

The Ministry of Health has recently (1 June 2020) issued "Guidelines for the progressive re-activation of planned healthcare services considered deferrable during the COVID-19 emergency" to regions, for both outpatient and inpatient care. The implementation of these guidelines by the regions is absolutely crucial in preventing a progressive extension of waiting lists for patients whose clinical conditions are worsening. The acceleration of medical cycles, and a more intense use of diagnostic technologies and operating theaters, could be the solutions to implement in facing this new challenge. Nevertheless, the availability of extra resources (e.g., availability of doctors and nurses) is necessary to increase the productivity of the healthcare system in this situation.

The lack of this acceleration could have long term implications in terms of clinical outcomes for individual patients, with a deterioration of basic health status indicators, such as mortality and disability.

AUTHOR CONTRIBUTIONS

RDB and AC contributed to the design, implementation of the research, to the analysis of the results, and to the writing of the manuscript. All authors contributed to the article and approved the submitted version.

SUPPLEMENTARY MATERIAL

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COVID-19 Pandemic Management Strategies and Outcomes in East Asia and the Western World: The Scientific State, Democratic Ideology, and Social Behavior

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INTRODUCTION

In December 2019, a new strain of Coronavirus, later identified as SARS-CoV-2 (Severe Acute Respiratory Syndrome Coronavirus 2) or COVID-19, began to surface in Wuhan, China. By February 2020, COVID-19 had become a pandemic which required emergency measures across the globe. However, regions in East Asia and Europe adopted different pandemic strategies which led to different outcomes. This article approaches different public health strategies, from both natural science and social science perspectives through the lens of East Asia and the Western world in three ways. First, using peer-reviewed scientific literature from the fields of infectious disease, medicine and public health, it examines how Hong Kong and its medical community dealt with the SARS outbreak in 2003 and the COVID-19 pandemic in 2020. This is important because Hong Kong has been acknowledged by the scientific community for having the most effective COVID-19 strategy (Gibney, 2020). Second, using scientific literature as a point of departure, it argues that Hong Kong, Taiwan, Singapore and South Korea (known as the Four Asian Tigers or East Asian Miracle) excel in STEM (science, technology, engineering, and mathematics) subjects that provide citizens with the skills to understand the science behind dealing with COVID-19. This article introduces the concept of the "scientific state" to capture such observation which goes beyond the popular belief that East Asian societies are better at obeying pandemic strategies set out by authorities in comparison to the West. Third, and building on the last point, it explores how social norms play an important role in dealing with the pandemic. The article concludes by arguing that an attitude of Anglo-European exceptionalism meant that successful strategies in the East were overlooked and led to undesired outcomes from Western management of the pandemic. Nonetheless, regions in East Asia did extremely well in containing COVID-19 not because of citizens were obedient to undemocratic pandemic management rules, but competent medically trained government ministers set out rules which citizen with high STEM proficiency understood and respected.

MANAGEMENT STRATEGIES OF SARS AND COVID-19: A SCIENTIFIC APPROACH IN EAST ASIA

After the SARS outbreak in Hong Kong that originated in mainland China in 2003, measures were drawn up by experts that included the introduction of preventive education and publicity, tracing the source of infection, isolating and carrying out surveillance of contacts, closing educational

institutions, checking body temperature at borders, deploying public cleansing campaigns and conducting diagnostic tests (Lee, 2003). Significantly, strategies used for containing SARS can also be used for COVID-19 to reduce cases and deaths (Wilder-Smith et al., 2020). Hence, in the absence of pharmaceutical interventions, Hong Kong managed to reduce the COVID-19 transmission rate by influencing public behaviors without lockdowns (Cowling et al., 2020). Similarly, rapid widespread testing and contact tracing strategies in South Korea were effective in containing the COVID-19 virus without lockdown (Lee and Lee, 2020). Nonetheless, implementing such strategies requires political will to ensure that the "short-term cost of containment will be far lower than the long-term cost of non-containment" (Wilder-Smith et al., 2020).

Since the SARS outbreak, usage of facemasks by the wider population has been adopted in Hong Kong and other East Asian regions. Research suggests that widespread use of surgical masks and N95 respirators is beneficial when worn properly and used alongside other strategies to control outbreaks (Chan and Yuen, 2020). Furthermore, since Coronavirus respiratory droplets and aerosols are exhaled when breathing and coughing, "surgical face masks could prevent transmission of human coronaviruses and influenza viruses from symptomatic individuals" (Leung et al., 2020). Additionally, since SARS-CoV-2 enters through the nose as well as other mucus membranes, the widespread use of masks can "prevent aerosol, large droplet, and/or mechanical exposure to the nasal passages" (Hou et al., 2020)[1]. Because of the widespread use of facemasks, over the past 5 years Hong Kong has experienced the shortest winter surge of seasonal influenza—5 weeks rather than the typical 12 to 18 week period (Chan and Yuen, 2020). Further statistical analysis shows that with 96.6 per cent of the population wearing facemasks in Hong Kong, confirmed COVID-19 cases were extremely low at 129.0 per million population (Cheng et al., 2020). This is significant because Hong Kong has the third highest population density in the world (7,140 per km^2) and is in close proximity to the original Chinese epicenter of the outbreak. Despite this, the fact that those populations experienced SARS has allowed them to become more aware of the risks posed by the current COVID-19 pandemic which resulted in preventive and protective measures being taken more seriously (Wilder-Smith et al., 2020).

USING AN IDEOLOGY TO SOLVE A MEDICAL PROBLEM: EAST ASIAN "SCIENTIFIC STATE" VS. WESTERN DEMOCRACY

Some commentators argue that draconian policies supposed to control the spread of the virus tend to make the pandemic worse (Giuffrida and Cochrane, 2020), and that democratic governments are better at controlling the virus (Ben-Ami, 2020).

However, this section argues that COVID-19 should be seen as a scientific problem rather than a political one.

A crisis such as COVID-19 highlights some Western government officials might not have taken scientific knowledge nor the pandemic seriously because they tend to be made up of career politicians such as the UK who have narrow occupational background and lack life experiences (Allen et al., 2020) but the opposite trend can be observed in Eastern governments. For example, the current Secretary of State for Health of the United Kingdom Matt Hancock does not have a background in medicine, nor does his predecessor Jeremy Hunt. In contrast, Sophia Chan, the current Secretary for Food and Health in Hong Kong was a professor in nursing and consultant to the World Health Organization (WHO). Moreover, Chen Shih-chung, the current Ministry of Health and Welfare in Taiwan was medically trained. As well, the former Vice President of Taiwan Chen Chien-jen is an epidemiologist. Furthermore, Park Neung-hoo, the current Minister of Health and Welfare in South Korea was a professor in social welfare. These countries have not experienced the problems of Western policies that have failed to check the spread of the virus and resulted in high death rates per million population:[2] Belgium 987; Denmark 124; France 560; Finland 65; Germany 125; Italy 634; Netherlands 428; Norway 52; Spain 767; Sweden 587; Switzerland 262; UK 680; US 709. In contrast, far fewer deaths per million population were reported in many South East Asian regions: Hong Kong 14; Japan 14; Macau 0; Malaysia 8; Singapore 5; South Korea 9; Taiwan 0.3; Thailand 0.8, Vietnam 0.4. This appears to be because they have been prepared for pandemics with excellent healthcare and warning systems. Furthermore, testing capacity has tended to be low in Europe and since there were no posthumous tests (Giugliano, 2020) that would uncover more cases than currently identified in death certificates, the actual rates of infection and deaths may be significantly higher than reported (Burn-Murdoch et al., 2020).

There is also an assumption in the West that populations in the East are Confucian and undemocratic, and therefore tend to be more obedient to rules. Perhaps Confucian ideas can be identified in some East Asian regions but Hong Kong, Japan, Singapore, South Korea, Taiwan, and so on have different forms of democracy. Most importantly, this article argues that the difference has more to do with governments of East Asia's "scientific states" for two reasons. First, these countries produced the most highly educated populations in the world; seven out of ten best performing countries / economies[3] in terms of mathematics and science are located in East Asia (OECD, 2019). Second, their populations value scientific leadership and excel in the STEM fields which are key to understanding the science of the pandemic.

It is evident that citizens of the East do not follow policies which are seen to be ineffective. For instance, in January 2020,

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[1]The US Centers for Disease Control and Prevention (CDC) publicly announced on 5 Oct 2020 that COVID-19 can be airborne, see https://www.cdc.gov/coronavirus/2019-ncov/more/scientific-brief-sars-cov-2.html.

[2]As of 31 October 2020, data obtained from:
Our Word in Data, https://ourworldindata.org/coronavirus#coronavirus-country-profiles
Johns Hopkins University
Worldometer, https://www.worldometers.info.
[3]China (Beijing, Shanghai, Jiangsu, and Zhejiang), Hong Kong, Japan, Macau, Singapore, South Korea, and Taiwan.

despite the number of imported cases continuing to increase in Hong Kong, the government did not close its borders with mainland China (Chan, 2020). But in February, when thousands of doctors and nurses went on strike, the government reversed its decision.

Moreover, despite the proven effectiveness of the widespread use of facemasks, the WHO and some governments, such as the UK, initially did not recommend it. There are at least four reasons for this. First, a global shortage of personal protective equipment (PPE) affected availability and guarantee supply to the public could not be guaranteed (Pickard and Asgari, 2020). Moreover, although the US Centers for Disease Control and Prevention (CDC) recommended their citizens should consider the use of face coverings from April 2020 (Fisher et al., 2020), it was left up to each US State to decide on how such recommendation should be adopted as policy and implemented. In addition, some countries such as Finland (Ministry of Social Affairs Health, 2020) and the Netherlands (Reuters, 2020) initially did not recommend the use of facemasks based on their own scientific experts' opinion, but later reversed the decision. And some countries such as Sweden did not recommend the use of facemasks at all (Milne, 2020a). Problematically, since most people infected with the virus are asymptomatic or only show mild symptoms (Randolph and Barreiro, 2020), they often cause the virus to spread without realizing.

Second, many Western governments have been concerned with the wider implications for civil rights because a "mask mandates use the coercive power of the state to require a person to do something that they would otherwise not choose to do" (Blunt, 2020).

Third, some governments argued that wearing facemasks might be a source of "social stigma and discrimination against those who do not wear one" (Royo-Bordonada et al., 2020).

Fourth, some countries aimed to achieve "herd immunity" — deliberately allowing citizens to become infected by the virus in order to create antibodies in the general population—in order to protect the economy and freedom of movement. However, while variations of herd immunity were implemented in the initial stage of the pandemic in countries such as the Netherlands (Holligan, 2020), Sweden (Henley, 2020) and the UK (Parker, 2020), they were later reversed. In contrast, none of the governments in East Asia implemented such a policy for their citizens.

Achieving herd immunity results in large numbers of infected people and deaths (D'Souza and Dowdy, 2020) which should not be the "ultimate goal" for controlling COVID-19 (Randolph and Barreiro, 2020). Further evidence shows that recovered patients can suffer from permanent damage to the lungs and other organs (Zhong et al., 2020) which is known as "long Covid" (Mahase, 2020).

Given Sweden's low population density, it suffered from one of the highest COVID-19 death rates in the world which reflected the failure of herd immunity. The elderly population were refused hospital treatment even when COVID-19 was in care homes, and this group accounted for 48.9 per cent of total deaths (Savage, 2020).

SOCIAL BEHAVIOR

The East and West diverge in how individuals react to various pandemic measures, and this has contributed to different rates of spread through the population. Rather than Confucianism producing strict adherence to rules, its emphasis on respect for family and society (Tu, 1996) is what contributes to the difference. Thus, the communities of many East Asian regions worked together harmoniously and, for instance, did not object to waiting in long queues to buy facemasks. The Confucian notion of kinship is also reflected in the practice of sending facemasks from East Asia to friends and families across the globe. For example, during the shortage of PPE, a New York based journalist reported receiving facemasks from a Chinese friend in Beijing, and this trend was widely reported across the globe (Tett, 2020). Above all, citizens believed in the measures based on scientific evidence put in place to deal with the virus and acted (collectively) to reduce the transmission rate.

Some countries such as Italy and Spain also have a strong idea of familialism which prioritizes family values. However, individual freedom seems to be equally important because some Italian and Spanish citizens have not respected the rules for social distancing and wearing facemasks. Moreover, anti-lockdown protests have taken place in Italy (Deutsche Welle, 2020) and Spain (BBC News, 2020). The Italian Foreign Minister Luigi Di Maio called on the "coronavirus deniers to at least show respect for the families of the dead" (Deutsche Welle, 2020).

In May 2020, a number of anti-lockdown protests took place in the UK, Germany and the US over loss of civil liberties, despite the fact that breaking lockdown rules has contributed to the spread of the virus. Although some protests took place in China, they were small-scale, peaceful and social distancing was observed. And in contrast to Western countries, the protesters were small business owners who demanded landlords should reduce rents—they were not fighting for freedom of movement (Bloomberg News, 2020).

Certain Western countries such as Denmark (Milne, 2020b), Finland and Germany were praised for having successful pandemic strategies (Ben-Ami, 2020) due to low death rates in comparison with other Western countries. However, when comparisons are made with Eastern regions such as Hong Kong, Japan, Singapore, South Korea, and Taiwan, it is evident that the East has proven to be significantly more successful in managing the pandemic.

Problematically, the concept of public health has not been respected by some citizens in the West. This might be due to a public perception of the conflicts of interest in the close relationships amongst politicians, scientists and the pharmaceutical industry. Further, the MMR (Measles, Mumps, and Rubella) vaccine scare (Godlee et al., 2011), and the opioid crisis in Europe (Verhamme and Bohnen, 2019) and the US (The Lancet, 2017) have generated distrust of medical science and related fields of research. Profits are seen to be placed above the well-being of citizens. Perhaps raising the overall standard of science education could help the general public to understand scientific knowledge.

CONCLUSION

This article highlights how East Asian governments made use of medical knowledge, public health expertise and social behavior to combat COVID-19. It further argues that a scientific state and competent population excelling in STEM subjects helps these societies in understanding and dealing with the pandemic.

In contrast, different pandemic strategies and versions of herd immunity were adopted for economic and social reasons (Fidler, 2020; Orlowski and Goldsmith, 2020) by some Western governments. This shows how politics can influence (Gonsalves and Yamey, 2020) the effectiveness of managing a pandemic in the West even though scientific knowledge from the East was available.

Above all, South Korea's COVID-19 management strategy has proven to work and the country subsequently reported an economic growth of 1.9 per cent in the second quarter of 2020, the sharpest rise in GDP in a decade (White, 2020). This shows that despite the current global pandemic, a competent government can lead a country out of a crisis.

When some Western countries experienced relatively lower numbers of COVID-19 cases, they were praised by commentators for their democratic and progressive ideology. However, when East Asia did extremely well in containing the virus, the West believed it was because East Asian countries are Confucian and draconian, and hence, obedient to undemocratic lockdown rules.

The anti-Asian sentiment and origin of the virus made it challenging for the West to seek pandemic solutions from the East. Perhaps the belief in Anglo-Eurocentric exceptionalism remains the West's biggest barrier to fighting COVID-19. This article highlights the importance of a constructive dialogue between experts which allows the exchange of the best pandemic strategies from across the world.

AUTHOR CONTRIBUTIONS

The author confirms being the sole contributor of this work and has approved it for publication.

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Consequences of COVID-19 Outbreak in Italy: Medical Responsibilities and Governmental Measures

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The COVID-19 pandemic has shocked the world causing more victims than the latest global epidemics such as Severe Acute Respiratory Syndrome Coronavirus (SARS-CoV) in 2003, and the Middle East Respiratory Syndrome Coronavirus (MERS-CoV) in 2012. Italy has been one of the most affected countries, and it had to deal with an already weak economic condition and cuts to public health services due to budgetary requirements from the last decade—something that made the situation even more dramatic. Deaths have exceeded 600.000 worldwide. During the emergency, regulatory measures were taken to counter the situation. This study highlights the main anti-COVID-19 government measures to support doctors and healthcare professionals, and it analyzes how to respond to the many requests complaining about neglectful healthcare professionals during the spread of the infection. For all those healthcare workers who died on duty, a compensation plan is assumed through a solidarity fund. The same solution cannot be granted to all patients, given the difficulty in assessing the responsibility of the doctor not only during an emergency but with insufficient instruments to cope with it as well.

Keywords: health emergency, Italy, government measures, bonus, medical responsibility, COVID-19

INTRODUCTION

The SARS-CoV-2 outbreak, which has been declared a pandemic by the World Health Organization (WHO) on March 11, 2020, has shocked the world (1). The medical class has been immediately the frontline, called to face a great emergency, worsened by the sudden spread of the infection (2).

In Italy, due to the many cuts to public health services of the past few decades, the emergency has been experienced by healthcare professionals as a sacrifice (3). The public health sector was completely unprepared for such a serious event. As a result, the Italian Government has implemented exceptional urgent regulatory measures to support the population that was quickly sinking into an economic crisis, the most serious one since the Second World War.

The health situation before the pandemic saw the protection of elderly people as a milestone since the aging process of the Italian population was strong and with a low fertility rate (1.29 children per woman) (4).

The pandemic exposed the weaknesses of the Italian health system, probably due to the lack of foresight in the political and socio-health fields. In recent years, action has been taken aiming at economic efficiency and savings, though neglecting the negative effects due to poor investment in health. Investments that could have indirectly generated social and economic benefits, with an increase in people's quality of life (4).

The emergency required the reorganization and increase of resources, which proved to be insufficient. In the initial phases of the pandemic access to treatment could have been diluted, to cope with the very high number of hospitalizations of COVID-19 patients that occurred during the lockdown (4).

This situation could be linked to the decentralized organization of public health in Italy, where the regions can act and face the pandemic with a certain freedom, not always in harmony with each other and with the central government (4).

From 2001 to 2019, the state health-requirement in absolute terms has increased, passing from 71.3 billion in 2001 to 114.5 in 2019. If 10 years ago the 105.6 billion euros were 7% of national wealth, in 2019 114.5 billion was 6.6%: a 0.4% cut in GDP in 10 years, which bears the signature of the governments Berlusconi IV, Monti, Letta, Renzi, Gentiloni, Conte (4).

From the GIMBE Evidence for Health foundation report, in the decade 2010–2019, the public financing of the National Health System increased by 8.8 billion euros, growing on average by 0.9% per year, a rate lower than that of inflation annual average growth of 1.07% (5).

So, it grew in absolute terms, but less than inflation.

Besides, another 37 billion euros had been promised for the National Health System, of which 25 billion in 2010–2015 resulting from cuts due to financial measures, and 12 billion in 2015–2019 for public finance needs. Therefore, fewer resources have been allocated to Healthcare than those planned and calculated based on health requirements (5).

The struggle against the virus took place in the hospitals, with fewer and fewer intensive care beds available and the health personnel forced to overwork. Frequently, medical and health personnel have been stuck in hospitals with heavy work shifts due to the lack of other colleagues. Very often doctors and nurses have been infected and deceased (6).

The Italian government has issued a series of decrees to support the population and the medical class, in such a difficult situation (7, 8).

In this work, only the laws enacted as an emergency response are considered.

These measures are aimed at financially facilitating the population and consist of economic bonuses, reduction or suspension of taxes, credit instruments, and guarantees for businesses and support for family life. Banks and insurance companies have also tried to adapt to the situation by offering new products and services.

CONTEXT

This study reviews the major measures issued by the Italian Government to support the medical class during the emergency (9).

The three decrees of the Prime Minister issued in the heart of the COVID-19 emergency were taken into consideration.

The period taken into consideration begins with the WHO pandemic declaration on March 11, 2020, and ends on June 4, 2020, that corresponds to the gradual re-start of activities.

In this context, the need to evaluate the claims for damage coming from wrongdoing that's reaching the judicial offices has been analyzed.

After these challenging months, the first requests for doctors' professional responsibility are emerging, due to the numerous deaths, especially those that occurred in hospitals and protected residences for the elderly.

These requests are based on the alleged inadequacy of facilities concerning anti-contagion precautions for patients and the elderly—despite the health of these patients are more vulnerable.

Authors agree that, in an emergency such as that caused by SARS-CoV-2, the doctor's professional liability law should become milder and adjusted to the pandemic context.

In case the doctor's responsibility is not attributable, the doctor cannot be blamed for civil and criminal liability, especially in an emergency context. In this emergency, with the inability to perform autopsies, it is difficult to state if the death has been caused by COVID-19 or other concomitant causes.

In this context, the measures taken by the Italian government mainly concerned financial and organizational benefits for all workers in the health sector who found themselves unemployed due to the pandemic.

The aim of the "Cura Italia" and "Liquidity" decrees is to strengthen the human and instrumental resources of the national health service in the fight against the pandemic.

DISCUSSION

"Cura Italia" and "Liquidità" Decrees

To help the national health system in this emergency, the Italian Government has issued some decrees (10). The most significant one is the decree called "Cura Italia." The decree intervenes on four main fronts and other sectorial measures:

1. Funding and helping the national health system with more measures, civil protection and other public entities engaged on the emergency front;
2. Support for workers and employers to protect work and income continuity;
3. Credit support for families and micro-, small- and medium-sized companies, through the Central Guarantee Fund (CGF), (Article 49). The CGF authorizes the financing that the company requests from the banking system. It also intervenes in favor of the "CONFIDIS" (Collective Guarantee Consortium of Loans, which carries out guaranteeing activities to facilitate businesses), taking full responsibility in case the financial agreement is not paid off (8).
4. The suspension of tax payments (Article 62) concerns the income of workers who carry out businesses, art or professional activities with revenues of <€2 million, and for all of those in the so-called "Red areas," whose income tax deadlines for payments were February 21, March 8, and March 31, 2020 (8).
5. Suspension of payment obligations for taxes and contributions as well as other obligations and tax incentives for the sanitation of workplaces and bonuses for employees who remain in service.

TABLE 1 | Summary of the main contents of the "Cura Italia" and "Liquidity" decrees promulgated by the Italian government.

Decree	Health sector	Labor sector
"Cura Italia" (7)	• funds for 150 million to pay overtime shifts to doctors and nurses • the master's degree in medicine and surgery becomes qualifying for the practice of the medical profession	• 600–1000€ bonus possibility to purchase baby-sitting services due to the forced closure of schools • Possibility to obtain bank loans without guarantees • Suspension of payment obligations for taxes and contributions as well as other obligations and tax incentives for the sanitation of workplaces and bonuses for employees who remain in service • Possibility to renegotiate existing loans • Extension of the tax credit for 50% of the costs of working environments sanitization, and also for the purchase of personal protective equipment
"Liquidità" (8)	• The state income support provides €600,00 to freelancer medics who have seen their turnover decreased by more than 33% starting from March and for no more than 90 days	• Credit support for families and micro, small- and medium-sized companies, through the Central Guarantee Fund (CGF) • The suspension of tax payments (Article 62) concerns the income of workers who carry out businesses, art or professional activities with revenues of <€2 million, and for all of those in the so-called "Red areas"

The decrees promise concrete aid to doctors during the SARS-CoV-2 emergency (**Table 1**). One of the first measures allocates funds for 150 million to pay overtime shifts more to doctors and nurses working in hospitals during the coronavirus outbreak. Among the measures for health personnel, there is the chance to keep on duty also the physicians who are about to retire. The master's degree in medicine and surgery immediately becomes qualifying for the practice of the doctor-surgeon profession, exempting the state exam during the outbreak period. An examination that, according to Italian law, must be passed by a graduate in medicine and surgery before he can operate professionally as a doctor. The state income support provides €600,00 to freelancer medics who have seen their turnover decreased by more than 33% starting from March and for no more than 90 days. In addition to that, there is a bonus of €1.000,00 for physicians, paid by ENPAM, the social security institution for this category (8). Article 22 of the decree extends the lay-offs even to employers that employ even just one employer as study staff. In support of families, the "Cura Italia" decree also provides professionals with the possibility of obtaining a €600.00 bonus for the purchase of baby-sitting services, according to the forced closure of schools. The bonus

rises to €1,000.00 for employees of the health sector, public and privates belonging to the category of doctors, nurses, and other health professionals. Furthermore, health professionals who hold a first home loan will be able to request the suspension of its payment if they have experienced a decrease in turnover of more than 33% in a quarter, following February 21, 2020, compared to the last quarter of 2019.

For doctors who are included in micro, small and medium-sized enterprises, including individuals, damaged by the COVID-19 epidemic, the decree introduces the suspension of mortgages and other installment loans or leasing until September 30, 2020. Another measure for professionals (including doctors) is the possibility of obtaining bank loans without guarantees, thanks to an agreement with the "Cassa Depositi e Prestiti." The latter is an Italian Financial Institution controlled by the Ministry of Economy and Finance with the mission of promoting the country's growth and managing postal savings. Up to 80% of the requested amount can be obtained by invoking the public guarantee fund for small and medium-sized enterprises and professionals, or up to 90% through certain credit guarantee agencies (CONFIDI). This possibility can also be used to renegotiate existing loans. Also, self-assessment payments that expire in the period between March 8, 2020 and March 31, 2020 are suspended for individuals carrying out business, art, or other professions. For the same subjects, the decree recognizes "a tax credit" up to 50% of the documented costs of environment sanitizing and working tools up to a maximum of €20,000.00."

Moreover, the decree of April 8, 2020 guarantee an extension of the tax credit for 50% of the costs of working environments sanitization, and also for the purchase of personal protective equipment, such as face masks and safety goggles (7).

New Measures for Credit and Insurance

The most important medical federations such as Ente Nazionale di Previdenza ed Assistenza dei Medici e degli Odontoiatri (ENPAM), Federazione Nazionale degli Ordini dei Medici Chirurghi e degli Odontoiatri (FNOMCEO), and Federazione Italiana Medici di Medicina Generale (FIMMG) have decided to set up a working group to strengthen the protection for doctors, currently engaged in the containment of the spread of SARS-CoV-2 (11). This working group will evaluate the chance to extend the protection provided by the National Institute for Accidents at Work (INAIL) to freelance and/or affiliated doctors and dentists (who are not currently benefitting from the insurance coverage of INAIL) (12).

There are also contractual increases for family doctors, pediatricians, and outpatient specialists during the COVID-19 outbreak to allow doctors to equip themselves with technological tools for patient telemonitoring, for a total of 400 million euros.

Even for small-professional doctors, there is a 100% guarantee for new financing, with a maximum duration of 6 years without evaluation procedure, for a maximum amount of €25,000.00. Furthermore, tax deadlines have been extended (13).

Insurance companies are also offering optional services and supplementary policies, recognizing indemnities in case of hospitalization, cash bonuses, special medical visits, teleconsultations, etc. Insurance companies have created *ad*

hoc products and supplemented health policies with specific services. Free of charge and temporarily, some companies have extended guarantees and services included in health insurance policies to let insured persons affected by the virus get daily indemnities in case of home quarantine, and compensation in case of hospitalization in intensive care (14).

INAIL has included in the category of accidents at work COVID-19 infections for doctors, nurses and other operators of health facilities in general, employees of the national health system and any other public or private structure insured with the Institute, occurred in the workplace or simply due to the working activity (15).

The public or private company has the task of promptly communicating to the competent authorities the health conditions of its employees regarding a possible coronavirus infection.

The initial term of INAIL protection is the date of contagion confirmation through specific tests. Healthcare workers who are quarantined for public health reasons are excluded unless they are positive. In this case, they are protected for the entire quarantine period and any subsequent time due to protracted illness, which determines temporary incapacity to work. Finally, considering that the infection may occur during home-work travel, the hypothesis of an on-going accident is taken into consideration.

The Professional Responsibility of the Doctor

Although healthcare professionals are fighting the pandemic with tough work shifts and shortages of staff and resources, several claims for professional liability have been received (15). The epidemic weighs heavily on the performance of healthcare professionals and can give rise to civil liability judgments (contractual and extra-contractual) against them, in all cases in which a medical error can be identified to the detriment of a patient suffering from COVID-19.

For this reason, the federations and national councils of health and socio-health professions, and the Ministry of Health have collected their considerations in a series of proposals to amend the law on the liability of professional doctors (16).

The need for such maneuvers derives from the fact that there are currently no clear regulations establishing the procedures for attributing medical responsibility in case of health emergencies. The current legislation is limited to blaming negligent, superficial, and repetitive conduct.

The main proposals consist of a provision that limits the liability of the health care professional during the emergency period to malicious assumptions—but also, an "evident" prediction of gross negligence, with the restriction of liability to "gross" fault cases. These limitations should be implemented both in civil, criminal, and administrative cases. The aim is to avoid a long judicial involvement to the detriment of doctors, but also to protect all those who, out of a pure spirit of generosity, made themselves available in the emergency even without so much experience, physicians called back into service, or with different specializations (17).

The contexts in which the provision was deemed applicable concern necessarily extraordinary and exceptional cases, as "not adequately studied by science or tested by practice."

The proposed changes also involve the responsibility of public and private hospitals forced to work with limited resources and by adapting ordinary activities into emergency activities.

It should be mentioned that the health policy choices in Italy have severely penalized healthcare in the past few years, reducing funds dramatically (18).

To give an example, Germany spends €3.600,00 in healthcare per year for each German citizen, while Italy spends €1.800,00. Intensive care beds in Italy in 2017 were 8.5 per 100,000 inhabitants, whilst in Germany, these were 34 in the same period (19).

As for compensation for damage from COVID-19, two groups of recipients can be distinguished: (1) health workers killed by the virus for work reasons, and (2) victims of the pandemic among ordinary citizens. Those who contracted the virus by sacrificing their lives serving the country as doctors, nurses, and pharmacists and all collaborators involved in the coronavirus emergency must be compensated (20).

The hypothetical form would be compensated with a solidarity fund for the victims. Some jurists refer to these victims as the so-called "victims of duty" (21).

The situation is more complex for infected and deceased citizens. Even if the cases were restricted to misconduct or gross negligence, a solidarity fund can hardly be conceived as for health workers for several reasons. First of all, the verification of the fault, which is carried out in the aftermath, will depend on the competence of the doctor, on the objective conditions of the patient, and on the context in which he found himself operating. Farther to the fault, the connection must be ascertained. Something to be equally sure about is the correct behavior the doctor should have had to save the patient. All of this is not easy to determine, as nobody knows exactly about the "behavior" of this virus, and it would be difficult to establish in a court "what would have happened if" the patient had been managed in a way or another. Contributing factors such as advanced age, the frequency of associated diseases also play an important role. Last, but not least, not enough swabs or autopsy have been made. Ergo, it will be difficult to tell the difference between "coronavirus-caused" or "with coronavirus" death.

LIMITATIONS

Some limitations apply to this work. The legislative experience described can be used as a starting point for future measures by other nations. However, this work deals with regulations promulgated in Italy, which has legislation and a national health system that may be different from those of other countries.

The judicial system may also differ, with differences in handling malpractice requests due to the fight against COVID-19.

CONCLUSIONS

The SARS-CoV-2 virus has shocked the world causing more victims than recent similar outbreaks.

A treatment protocol, as well as an effective vaccine, are currently under study, but these have not been identified yet (22).

Italy, the third country after China and Spain to be infected as of May 2020, had to deal with an already weakened economic situation and important cuts in healthcare which immediately made the situation very complex (23).

The health professionals worked in an exemplary manner even without suitable or effective protection measures (24, 25).

The need to recover and face the emergency has prompted the Government to promote an emergency decree (26).

There was no shortage of criticism for these measures, from the accusations of unconstitutionality of the lockdown to the long times for the disbursement of the bonuses to the failure to insert some subjects as beneficiaries of the bonuses. It does not seem possible to limit liability to cases of willful misconduct because, even in an emergency, the possibility of errors is increased. In this outbreak context, there are no established guidelines or good practices, and there are no aids to measure diligence and responsibility (17). The evaluation should be limited to cases of gross negligence by the doctor, willful misconduct, or fault for employer liability. In a scoreboard by the Deep Knowledge Group study which analyzes the capacity, scope, diversity, efficiency, and effectiveness of government measures to provide economic support to citizens and businesses, Italy ranks in the tenth place in the world for resilience (27). The renowned Italian ability to bring out the best during emergencies.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

AUTHOR CONTRIBUTIONS

GR and GN: conceptualization, data curation, formal analysis, investigation, methodology, and writing. GP: supervision, validation, formal analysis, and writing—review and editing. AS and FA: supervision and validation. All authors contributed to the article and approved the submitted version.

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Knowledge, Attitudes, and Practices Toward Coronavirus Disease 2019 in the Central Area of Iran: A Population-Based Study

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Background: The spread of the coronavirus disease 2019 (COVID-19) pandemic has imposed high threats on global health, life and work style, and social and economic development. The current study aimed to extract knowledge, attitudes, and practices related to COVID-19 among the general population in the central area of Iran.

Method: A cross-sectional study was conducted in Arak City between April and May 2020. Stratified random sampling was applied to select the study participants. Phone interview was applied to collect the data. Data were collected using a questionnaire that was constructed and validated in this study. The questionnaire included demographic variables and items about knowledge, attitudes, and practices toward COVID-19. Descriptive and inferential analyses were conducted in STATA software.

Results: In total, 544 participants completed the questionnaire; 76% of the participants accounted COVID-19 as a high threat 1 month from the onset of COVID-19. From the maximum attainable scores of 1, 6, and 6, for COVID-19-related knowledge, attitudes, and practices, means of 0.77 (0.13), 4.97 (0.63), and 5.35 (0.70) were obtained, respectively. Females had a higher practice score (5.4 ± 0.6). The participants with a family history of heart and respiratory diseases had significantly higher attitude and practice scores. SMS from the Ministry of Health had a significant impact on knowledge, attitude, and practice scores ($p < 0.05$).

Conclusion: Higher attention should be given to increase the knowledge, attitudes, and practices of men and the housewife group. COVID-19 preventive messaging from the Ministry of Health was among the most influential methods of increasing knowledge that attracted public attention.

Keywords: knowledge, attitudes, practices, COVID-19, Iran

INTRODUCTION

An emerging highly infectious disease with the main symptoms of dry cough, dyspnea, and fever called coronavirus disease 2019 (COVID-19) was first diagnosed in December 2019 in Wuhan City, China (1). Its ongoing spread, across countries and continents, has evoked the World Health Organization (WHO) to declare it as an international public health emergency on January 30 and requested collaborative efforts of all countries to contain its rapid spread (2). Regarding Iran, the first cases were reported from Qom Province on February 19, 2020, and then, several days later, in Markazi Province, as the second place, the location where the current study was performed (3–5).

The spread of COVID-19 has imposed high threats on global health, life and work style, and social and economic development (6, 7). To face this threat, countries have issued many guidelines on different aspects of prevention and control of COVID-19 (8). These guidelines are not effective unless the knowledge, attitudes, and practices of the public are improved. Lessons learned from the severe acute respiratory syndrome (SARS) epidemic point out that high knowledge, attitudes, and practices (KAP) toward different epidemics decrease stress and panic and pave the way toward their prevention and control (9, 10). Also, high public awareness toward Ebola and the Middle East respiratory syndrome (MERS) provided the background to control them (11, 12).

To plan and design effective and universal healthcare packages on COVID-19, it is necessary to extract KAP of the public, which this study aimed to perform. This study indicated the shortcomings and gaps between what COVID-19 measures have been performed and what needs to be performed in terms of improving public KAP.

As Arak city was among the first cities that have reported cases of COVID-19 (7) and also due to its geographical position that connects many provinces to each other (7, 13), the city can be introduced as one of the main COVID-19 epicenters in Iran. On the other hand, understanding the public KAP toward COVID-19 facilitates its management and control. So, the current study was performed to extract knowledge, attitudes, and practices related to COVID-19 among the general population in the central area of Iran.

METHODS

This is a cross-sectional study conducted in Arak City, Iran. Arak is the capital of Markazi Province in the center of Iran with an estimated population of nearly 600,000 people (13). The study was conducted between April 11 and May 2, 2020. The source population for this study was all the female and male population living in Arak City.

In order to obtain a representative sample, stratified random sampling was applied to select the study participants from the source population. First, the population was divided into 50 strata, based on the centers providing health services. From each stratum, the participants were selected by simple random sampling based on the proportion and size of each center. All people older than 18 years old were eligible for the study.

A phone interview was applied by 10 health providers to collect the data. The phone number list was extracted from the SIB system (in Persian: Samane Yekparcheh Behdasht or Integrated Health Record System), where the household's characteristics of each stratum are registered by the centers. Interviewers attended a training session before collecting the data. The SIB system is a platform that provides the most comprehensive electronic health records on personal demographic information, records of diseases, medical records, and all information affecting individual health. The interesting point about this system is that it has interactions with other systems aside from the Ministry of Health and Medical Education such as the Insurance System, Forensic Medicine, etc. This system has been established in more than 36,000 urban and rural regions around the country, employing more than 130,190 healthcare staff including Behvarz (primary healthcare providers), midwife, nurse, mental health expert, general physician, specialist, general dentist, etc. (14).

The proportion formula of $Z_{1-\frac{\alpha}{2}}^2 \times p(1-p)/precision^2$ was used to estimate minimum sample size [with estimated knowledge level 94% (15), 2% precision, 95% confidence level, and considering 10% nonresponse proportion], so the sample size obtained was 600. The total number of participants who

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TABLE 1 | The percentage of correct answers for knowledge items of the KAP questionnaire among the participants.

Knowledge items	Correct answer (%)
Do asymptomatic people transmit the disease to others?	77
Does arbitrary treatment of COVID-19 with different drugs useful?	77
Does washing hands with soap and water help prevent the disease?	96
Are people with chronic background diseases (such as cardiopulmonary diseases) considered as high-risk groups for coronary heart disease?	94
Can the correct use of mask in patients reduce the transmission of the disease?	95
Is COVID-19 transmitted through coughing and sneezing?	97
Can the disease be transmitted between humans and animals?	70
Can the disease be transmitted through well-cooked products?	54
Does going to crowded places increase the risk of infection?	95
Does touching elevator keys or bank passers-by transmit the disease?	95
Does staying home, and not leaving home as much as possible, have an effect on reducing the transmission?	95
In your opinion, do you have enough knowledge about COVID-19?	74
How long is asymptomatic time period for COVID-19?	60
How deadly can this disease be?	39
How often should a regular mask be replaced?	67
What part of the body is affected by this disease?	84

TABLE 2 | The percentage of attitude items for the KAP questionnaire among the participants.

Items	Strongly agree* N (%)
I'm worried about myself or a family member getting the disease.	173 (33)
I believe that the transfer of COVID-19 can be prevented by following national or international guidelines.	146 (28)
I believe that getting information about COVID-19 through social networks is enough.	60 (12)
I believe that wearing masks in crowded places is effective.	225 (43)
I believe that hand disinfection is effective in reducing disease transmission.	284 (55)
I believe that disinfecting objects is effective in reducing COVID-19 transmission.	254 (50)
I believe that COVID-19 can be treated at home.	113 (22)
I believe that washing hands with soap and water helps prevent the disease.	278 (53)
I believe that the correct use of mask can reduce the transmission of the disease to others.	238 (46)
I believe that the correct use of mask can reduce the transmission of the disease to a person.	210 (41)
I believe that mask should be changed every few hours.	215 (42)
I believe that staying home, and not leaving home as much as possible, has an effect on reducing the transmission.	293 (56)
I believe that touching the elevator or ATM keys is effective in the disease transmission.	301 (57)
I believe that going to crowded places increases the risk of infection.	348 (66)

Other points are not indicated.

TABLE 3 | The percentage of practice items of the KAP questionnaire among the study participants.

Items	Always* N (%)
I avoid crowded places and gatherings as much as possible.	291 (55)
I avoid entering closed places as much as possible.	258 (50)
I avoid raw foods as much as possible.	292 (56)
I use mask as much as possible in crowded places.	280 (54)
I cover my mouth and nose when I sneeze and cough.	322 (61)
I avoid touching my nose, mouth, and eyes as much as possible.	292 (56)
I always throw the used mask in the trash.	310 (60)
I avoid shaking hands with others as much as possible.	341 (65)
I disinfect objects as much as possible.	291 (56)
As much as possible, I recommend that a person with the disease symptoms to see a doctor.	291 (56)
I wash my hands with soap and water several times a day as much as possible.	337 (64)
I do not get close to another person as much as possible.	285 (54)
I change mask every few hours as much as possible.	256 (49)
I do not touch the elevator and ATM keys without protection as much as possible.	309 (58)

Other points are not indicated.

answered the questionnaire was 544, making the response rate of 91%.

Data were collected using the questionnaire constructed and validated in this study. In this regard, based on the literature and guidelines issued by the WHO (16), items related to KAP of COVID-19 were included. The content validity of the instrument was assessed by 10 experts in the fields of epidemiology, health education, and infectious diseases (with respect to simplicity, relativity, and importance). Then, internal consistency was assessed among 30 people by Cronbach's alpha. The questionnaire's validity and reliability were approved; Cronbach's alpha values for knowledge, attitude, and practice domains were 0.98, 0.95, and 0.91, respectively.

The study variables included age (years); sex (female/male); status (single/married); education (illiterate/elementary/intermediate/diploma/academic); job (housewife/office employee/working/others); family history of heart, blood pressure, and respiratory diseases (yes/no); accounting COVID-19 as a threat (not at all/very low/low/relatively/high/very high); and source of acquired information (TV and radio/family/friends/health staff/internet/SMS from the Ministry of Health/pamphlets and posters/others).

The knowledge section of the questionnaire with 17 items had "yes," "no," or "I don't know" answers. Correct and incorrect

answers scored 1 and 0, respectively. The attitude section had 14 items, and the answers were included on a six-point Likert scale (1, strongly disagree; 2, moderately disagree; 3, slightly disagree; 4, slightly agree; 5, moderately agree; 6, strongly agree). The practice section had 15 items and the answers were included on a six-point Likert scale (1, never; 2, very rarely; 3, rarely; 4, sometimes; 5, usually; 6, always). The items related to KAP of COVID-19 are presented in **Tables 1–3**.

Statistical Analysis

Descriptive and inferential statistics were applied by using STATA 12.0. Independent sample t test and one-way analysis of variance were applied to present differences in KAP of the population by demographic characteristics. Spearman correlation test was used to identify any correlation between knowledge, attitudes, and practices. $p < 0.05$ was considered in the all tests to indicate significance.

RESULTS

Descriptive Findings

In total, 544 participants completed the questionnaires. The nonresponse rate was 9% ($n = 56$) and these were the ones who did not answer the phone call. Mean age (SD) was 36 (10) years old. Females were 69% ($N = 376$) of the participants. Descriptive findings of other demographic characteristic are indicated in **Table 4**. Furthermore, 78% of the participants did not report any family history of heart and respiratory diseases. During 1 month from the onset of the COVID-19 epidemic, accounting COVID-19 as a high and very high threat was reported by 76% of the participants

TABLE 4 | Descriptive characteristics and comparison of COVID-19-related knowledge, attitudes, and practices in Arak in 2020.

Variable		N (%)	Knowledge		Attitudes		Practices	
			Mean (SD)	p value	Mean (SD)	p value	Mean (SD)	p value
Total	Mean (SD), min, max	544	0.77 (0.13), 0, 1	–	4.97 (0.63), 2, 6	–	5.35 (0.70), 2.3, 6	–
Sex	Male	167 (31)	0.79 (0.11)	0.13	4.94 (0.7)	0.49	5.2 (0.8)	0.02
	Female	376 (69)	0.77 (0.13)		4.98 (0.6)		5.4 (0.6)	
Age	Mean (SD), (min–max)	36 (10), (18–89)	r = −0.03	0.38	r = 0.03	0.45	r = −0.04	0.34
	0–25	53 (11)	ANOVA	0.38		0.97		0.67
	25–35	234 (47)						
	35–45	143 (28)						
	45–55	43 (9)						
	55–90	27 (5)						
Status	Married	489 (90)	0.77 (0.13)	0.1	4.97 (0.6)	0.84	5.35 (0.7)	0.9
	Single	53 (10)	0.8 (0.15)		4.95 (0.9)		5.33 (0.8)	
Education	Illiterate	7 (1)	r = 0.29	0.001	r = 0.08	0.09	r = 0.07	0.09
	Elementary	19 (4)	Spearman					
	Intermediate	67 (13)						
	Diploma	192 (36)						
	Academic	241 (46)						
Job	Housewife	260 (53)	0.75 (0.1)	0.001	4.97 (0.6)	0.97	5.38 (0.7)	0.06
	Office employee	107 (22)	0.84 (0.1)		4.97 (0.6)		5.40 (0.6)	
	Working	13 (3)	0.76 (0.1)		4.99 (0.7)		5.07 (0.9)	
	Others	109 (22)	0.77 (0.1)		4.94 (0.7)		5.20 (0.8)	
Family history of disease[1]	Yes	114 (22)	0.79 (0.1)	0.22	5.10 (0.5)	0.01	5.50 (0.6)	0.02
	No	414 (78)	0.77 (0.1)		4.94 (0.6)		5.31 (0.7)	
Accounting COVID-19 as a threat	Not at all	10 (2)						
	Very low	8 (1)	r = 0.17	0.001	r = 0.31	0.001	r = 0.30	0.001
	Low	18 (3)	Spearman					
	Relatively	93 (18)						
	High	211 (40)						
	Very high	189 (36)						

[1]Include heart, blood pressure, and respiratory diseases.

(**Table 4**). The most reported source of acquiring information about COVID-19 was TV and radio (86%) (**Table 5**). In total, from the maximum attainable scores equal to 1, 6, and 6, for COVID-19-related knowledge, attitudes, and practices, means (SDs) of 0.77 (0.13), 4.97 (0.63), and 5.35 (0.70) were obtained, respectively.

Analytical Findings
The results showed that females had a statistically significant higher practice score (5.4 ± 0.6) compared with males (5.2 ± 0.8); however, there was no significant difference between them for knowledge and attitudes. There were no differences in means of knowledge, attitude, and practice scores based on age and status of the participants. In addition, there was no statistically significant linear correlation between age with knowledge, attitudes, and practices. There was a weak positive correlation between knowledge and years of education, which was statistically significant ($r = 0.29$, $p = 0.001$), but there was no correlation between attitudes and practices with education. There was a statistically significant difference between job groups

($p = 0.001$) in acquired knowledge score. In addition, there was a statistically nonsignificant difference between job groups in the acquired attitude ($p = 0.97$) and practice ($p = 0.06$) scores. The results showed that participants with a family history of heart and respiratory diseases had significantly higher attitude ($p = 0.01$) and practice ($p = 0.02$) scores statistically compared with participants without a family history of heart and respiratory diseases. However, there was no statistically significant difference in the knowledge of the two groups ($p = 0.22$). There was a weak statistically significant positive correlation between knowledge ($p = 0.001$), attitude ($p = 0.001$), and practice ($p = 0.001$) scores in terms of accounting COVID-19 as a threat (**Table 4**).

There was a statistically significant difference in the means of knowledge scores for health staff, internet, and SMS from the Ministry of Health; attitude scores for TV and radio, family, internet, SMS from the Ministry of Health, pamphlets, and posters; and practice scores for TV and radio and SMS from the Ministry of Health as the acquired source of information ($p < 0.05$) (**Table 5**).

TABLE 5 | Characteristics of the participants by source of acquired information in Arak in 2020.

Source of acquired information		N (%)	Knowledge		Attitudes		Practices	
			Mean (SD)	p value	Mean (SD)	p value	Mean (SD)	p value
TV and radio	Yes	422 (86)	0.78 (0.11)	0.6	5.0 (0.6)	0.04	5.4 (0.7)	0.01
	No	67 (14)	0.77 (0.14)		4.8 (0.7)		5.2 (0.8)	
Family	Yes	78 (16)	0.79 (0.1)	0.3	5.2 (0.5)	0.006	5.44 (0.6)	0.3
	No	410 (84)	0.78 (0.1)		4.9 (0.6)		5.36 (0.7)	
Friends	Yes	58 (12)	0.79 (0.1)	0.4	5.1 (0.5)	0.4	5.32 (0.7)	0.6
	No	430 (88)	0.78 (0.1)		5.0 (0.6)		5.38 (0.7)	
Health staff	Yes	220 (45)	0.79 (0.1)	0.009	5.02 (0.6)	0.3	5.38 (0.7)	0.7
	No	268 (55)	0.77 (0.1)		4.95 (0.6)		5.36 (0.6)	
Internet	Yes	187 (38)	0.82 (0.09)	0.001	5.06 (0.5)	0.02	5.43 (0.6)	0.15
	No	301 (62)	0.75 (0.1)		4.93 (0.7)		5.33 (0.7)	
SMS from the Ministry of Health	Yes	210 (43)	0.81 (0.1)	0.001	5.06 (0.6)	0.02	5.44 (0.6)	0.047
	No	278 (57)	0.76 (0.1)		4.92 (0.6)		5.32 (0.7)	
Pamphlets and posters	Yes	61 (12)	0.80 (0.1)	0.15	5.13 (0.4)	0.04	5.45 (0.6)	0.3
	No	427 (88)	0.78 (0.1)		4.96 (0.6)		5.36 (0.7)	
Others	Yes	17 (3)	0.79 (0.1)	0.7	4.84 (0.7)	0.3	5.17 (0.5)	0.2
	No	471 (97)	0.78 (0.1)		4.99 (0.6)		5.38 (0.7)	

DISCUSSION

Due to high morbidity and mortality and the lack of a specific and effective treatment or vaccine, preventive measures and increasing public KAP play a unique role in confronting COVID-19. So, this study was performed to analyze these measures in one of the first Iranian provinces where COVID-19 cases were reported (7).

This study indicated that there was no significant relationship between the age of the participants and COVID-19 KAP. The published studies have reported contradictory results. Accordingly, the study of Al-Hanawi et al. on COVID-19 KAP among the public in Saudi Arabia indicated that older people have higher knowledge toward COVID-19 (17). In sum, it has been proven that age has a direct link with knowledge level (18). The reason behind the lack of relationship between age and COVID-19 KAP in the current study needs further studies. However, young people having higher access to social media and older people having higher experience in the face of diseases including COVID-19 have neutralized the effect of age on COVID-19 KAP.

The results indicated that although there is no difference in terms of knowledge and attitudes between men and women, women have higher COVID-19 practice scores than men. This means that men despite having the required knowledge and attitude perform lower preventive measures against COVID-19. This necessitates specific designs and programs targeting this group. The study of Bao-Liang Zhong et al. on Chinese residents indicated that women have good knowledge, optimistic attitudes, and appropriate practices toward COVID-19 (19). Another study by Chen Yan et al. stated that men adhere less toward wearing masks

and hand washing than women (20), suggesting that more focus should be given to men in designing preventive and educational programs.

This study indicated that although those with higher education level have higher knowledge related to COVID-19, it is not generalized to attitude and practice status. In other words, there was no significant difference between attitudes and practices toward COVID-19 among the participants with illiterate, elementary, and university literacy level.

The results indicated that the office employee group has the highest knowledge regarding COVID-19. The study of Rahman and Sathi on Bangladeshi internet users indicated that the likelihood of staying home and wearing mask increases by each unit increase in the knowledge score (21). This indicates the importance of improving knowledge status as the first step of developing healthy behaviors. The study of Azlan et al. on KAP of the general population showed that those working in the public sector have the highest positive attitude toward COVID-19. They described that this may be due to their affiliation to the government that leads to report a high positive attitude in this regard (22). However, the high knowledge of the employee group in this study may be due to workplace education, guidelines issued by the Ministry of Health for workers, and their higher literacy level than the public.

TV and radio were the media most frequently used by the participants to obtain information about COVID-19. The KAP study of Italian students toward COVID-19 by Souli and Dilucca showed that the most frequently reported media were television and then Facebook, WhatsApp, and Instagram (23). The participants reported that different media including TV and radio, Ministry of Health messaging,

pamphlets and posters, internet, and social media are effective on improving their knowledge, attitudes, and practices toward COVID-19. On the other hand, Chen Yan et al. stated that social media such as micro letter and QQ have replaced TV and radio and people no longer acquire their information through these traditional media [20]. However, it does not matter how COVID-19 information is obtained; the most important issue is supervising the media to provide reliable and relevant scientific information in a timely manner.

Study Limitations

This is among the first studies performed to extract the KAP of the general public toward COVID-19 in the central area of Iran, which is useful in designing interventional packages to control it. Although the questioners were educated to supervise on completing the questions, and also the importance of honesty and correct response by participants was emphasized, one of the issues threatening self-reporting studies is reporting bias that needs to be improved using administrative data in future studies.

CONCLUSIONS

The present study provided a comprehensive assessment of KAP of the general population. The results indicated that women have better COVID-19-related practices, education level is effective on COVID-19 knowledge, and TV and radio are the main sources of acquiring information. This study indicated that higher attention should be given to increase men's and the housewife group's KAP. COVID-19 preventive messaging from the Ministry of Health was among the most influential methods of increasing knowledge that attracted public attention.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by an oral and written informed consent was obtained from each participant prior to the interview. This study has been approved ethically by Research and Technology Deputy of Arak University of Medical Sciences (Ethical Code Number: IR.ARAKMU.REC.1398.328). The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

RM and SA designed the study, performed the statistical analysis, and drafted the manuscript. JN and MS revised the manuscript critically for important intellectual content and gave final approval of the manuscript. RM, SA, JN, and MS contributed to the conception and design of data. All authors contributed to the article and approved the submitted version.

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Medical Students' Awareness of Smell Loss as a Predictor for Coronavirus Disease 2019

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Background: Anosmia has been reported as an early presentation of coronavirus disease 2019 (COVID-19). However, the pathophysiological mechanism of olfactory dysfunction is still unclear.

Aim: The aim of this study to evaluate the knowledge regarding common symptoms, anosmia, treatment options, and PPE among medical students in three different universities of Saudi Arabia.

Methods: This cross-sectional survey conducted among medical students in Saudi Arabia. Google Forms was used to create the survey. The questionnaire included demographic information, knowledge of COVID-19 symptoms, sources of information, and the level of awareness of specific symptoms (loss of smell and taste).

Results: A total of 494 students completed the questionnaire. The majority of the participants were aware of common COVID-19 symptoms like fever and cough (79.8 and 67.2%, respectively), but less than half were aware that smell or taste dysfunction might be a symptom of COVID-19 (44.3 and 30.2%, respectively). The present study revealed that the source of information also plays a critical role in medical students' awareness regarding the symptoms of COVID-19. Students using international organization's websites, medical databases, or published research had better knowledge of anosmia as a COVID-19 symptom compared to those who used WhatsApp, Google, or unofficial social media pages. In our study, a minority (11.9%) of the participants relied on unofficial social media pages as the main source of their information.

Conclusion: Saudi medical students understand that smell or taste dysfunction can be a potential symptom of COVID-19, but this knowledge was not as widespread as the knowledge regarding the most common COVID-19 symptoms.

INTRODUCTION

Near the end of 2019, cases of atypical pneumonia of unknown etiology were discovered in Wuhan in the mainland of China. Later on, these cases proved to be linked to a viral infection caused by a novel virus of the coronavirus family; the International Committee on Taxonomy of Viruses had named it severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) (1). The infection spread,

leading to a major outbreak around the world. In February 2020, the World Health Organization (WHO) labeled this disease an epidemic and designated it coronavirus disease 2019 (COVID-19) (2). As the disease spread, multiple outbreaks were reported, leading to WHO announcing this disease to be a worldwide pandemic in early March 2020. In Saudi Arabia, the first positive case of COVID-19 was reported on March 2 in a Saudi citizen who had traveled to Iran through Bahrain (3).

The victims of this disease mostly presented with fever, cough, and shortness of breath (4, 5). Furthermore, smell and taste dysfunction have also been reported as a symptom of this new disease, which can affect patient quality of life (6–8).

Although the pathophysiological mechanism of olfactory dysfunction is still unclear, in many studies, anosmia has been reported as an early presentation of COVID-19. In one study, anosmia was the only presenting nasal symptom in 94% of confirmed patients (9). Similarly, in a recent systematic review, it was found that 41% of COVID-19 confirmed patients had olfactory dysfunction (10). Patients with a combination of anosmia and flu-like symptoms have been reported to be up to 10 times more likely to test positive for COVID-19 than if this combination is not present (11, 12). Consequently, many medical associations and societies have added this symptom to a list of screening tools for COVID-19 (13, 14).

As this epidemic continues to cross borders, it is imperative that medical providers be aware of prevention and early detection methods for this disease. Smell and taste dysfunction have been neglected symptoms, and the awareness of these symptoms needs to be emphasized. In this paper, we aim to determine the knowledge regarding common COVID-19 symptoms, smell and taste dysfunction symptoms and available treatment options/outcome, using personal protective equipment (PPE), and the primary source of those information, among medical students in Saudi Arabia.

METHODS

This cross-sectional survey was conducted among medical students in Saudi Arabia from June to July 2020. The survey was created in Google Forms and distributed via email and WhatsApp through medical student representatives and vice deans of medical colleges. The questionnaire was developed by the authors based on recent available literature. A pilot study was conducted to determine the clarity of developed questionnaire. The questionnaire included students' demographic information, current college year, university affiliation, knowledge of common symptoms of COVID-19 (fever and cough), and knowledge of potential changes to or loss of smell or taste caused by COVID-19. Furthermore, students were surveyed about their level of awareness of available treatment options for loss of smell based on the recent literature. In addition, students were asked about their sources of primary information regarding COVID-19. A five-point Likert scale ranging from strongly disagree to strongly agree was used to record participants'

responses. The questionnaire took an average of 11 min to complete.

Sample size was based on Raosoft's sample size calculator. The latest available estimate for the number of medical students enrolled in Saudi universities was 26,216 students. A sample size of 379 was chosen based on a 5% margin error and 95% confidence interval. However, a larger sample size of 494 students was obtained with a respond rate of 61%. A standardized general description about the study objective was included in the survey, and students voluntarily answered the questions.

The statistical analyses were performed in SPSS 26. Frequencies, descriptive statistics, normality tests, the t-test, the Mann–Whitney U-test, one-way analysis of variance (ANOVA), the Kruskal–Wallis test, correlation, and the chi-square test of independence were computed.

Four indicators were calculated based on the questionnaire. The common symptoms knowledge index was comprised of Q7 and Q8, the anosmia/dysgeusia knowledge index was Q9–Q18, the personal protective equipment (PPE) knowledge index was Q19–Q23, and the treatment option knowledge index was Q24–Q28. The response scale ranged from 1 (strongly agree) to 5 (strongly disagree), with the exception of Q16, which ranged from 1 (within 2 weeks) to 5 (I don't know). The answers were coded as 0 (incorrect) and 1 (correct) and summed up for each index.

In the next step, the anosmia/dysgeusia index, PPE index, and treatment index were summed up to create a triple index. Then, both the common symptoms index and triple index were recalculated into percentages of correct answers. Based on percentages, a category was assigned: poor knowledge (0% for common symptoms, ≤60% for triple index), moderate (50% for common symptoms, 61–80% for triple index), and good (100% for common symptoms, >80% for triple index).

RESULTS

Table 1 shows the cohort characteristics. A total of 494 students completed the survey, and 319 (64.6%) were male. Additionally, 95 students (19.2%) were in their fourth year, and King Khalid and King Saud University accounted for the largest proportion of participants.

Table 2 shows the frequencies and percentages of responses of the included participants regarding the knowledge of COVID-19. The majority of participants 427 (52.8%) knew that rise in body temperature as the symptom of corona disease. Likewise, 44.9% knew that cough, 60.1% knew that shortness of breath, and 35.6% knew that complete loss of sense of smell as the major symptom of corona disease. Furthermore, 36.3% of participants did not know that change in taste or taste of eating as the symptom of the corona. 48.7% of participants did not agree that loss or change of sense of smell requires hospital admission. Similarly, 51.7% of participants did not know that loss or change of sense of smell does not interfere with hospitalization. 35.7% did not know that sudden loss or change of sense of smell as the only symptom of corona infection. Moreover, 319 participants (39.4%) responded to question (In average, how long does the sense of smell lose

last from COVID19) "within 20 weeks," while 49 (6.1%) chose "1 month." Twenty-eight respondents (3.5%) answered with "more than 1 month." The majority did not know the answer (413, 51.1%).

Group Differences

Table 3 demonstrates the results of the Mann-Whitney *U*-test to highlight the differences. The findings on difference in knowledge regarding COVID-19 symptoms, anosmia, PPE, and treatment based on gender is shown. It was found that, both male and female had similar knowledge on symptoms, anosmia and treatment options. However, the knowledge of PPE

TABLE 1 | Demographic profile of the sample.

Variable/Group	n (%)
Gender	
Female	175 (35.4%)
Male	319 (64.6%)
Age	
M (SD)	22.14 (2.41)
College year	
First year	56 (11.3%)
Second year	72 (14.6%)
Third year	62 (12.6%)
Fourth year	95 (19.2%)
Fifth year	79 (16.0%)
Sixth year	48 (9.7%)
Internship	82 (16.6%)
University affiliation	
King Saud University	86 (17.4%)
Prince Sattam Bin Abdulaziz	83 (16.8%)
Imam Muhammad ibn Saudy	37 (7.5%)
King Saud bin Abdulaziz University for Health Sciences	62 (12.6%)
Al Qassim University	56 (11.3%)
King Khalid University	87 (17.6%)
King Abdulaziz	61 (12.3%)
Other	22 (4.5%)
Information sources	
Whatsapp	5 (1.0%)
Unofficial social media	59 (11.9%)
Official governmental accounts	288 (58.3%)
Google News	16 (3.2%)
Medical databases/published research	43 (8.7%)
TV	10 (2.0%)
International organization sites (e.g., WHO)	73 (14.8%)
COVID knowledge level	
Complete knowledge	153 (31.0%)
Partial knowledge	294 (59.5%)
Little knowledge	45 (9.1%)
No knowledge	2 (0.4%)

is significantly higher in female participants as compared to the male participants.

College Year

No significant differences were found for any of the four knowledge indices in terms of college year ($p = 0.692$ for common symptoms index, $p = 0.733$ for the anosmia index, $p = 0.742$ for the PPE index, and $p = 0.220$ for the treatment index).

University

Two noted some differences, but that they were not significant were identified in terms of the anosmia index. Namely, students from Al Qassim University (M = 4.39, SD = 2.43, Me = 5.00) scored significantly lower than students from Al Imam Muhammad Ibn Saud Islamic University Imam Muhammad ibn Saud University (M = 5.84, SD = 2.30, Me = 6.00; p =0.086) and students from other universities (M = 6.09, SD = 1.87, Me = 6.00; $p = 0.094$). **Table 4** showed university names cross different indexes.

Information Sources

In terms of anosmia knowledge, students who got their information from international organization's websites (M = 5.96, SD = 2.02, Me = 7.00) scored significantly higher than those who used WhatsApp (M = 2.20, SD = 2.28, Me = 2.00; $p = 0.007$), Google News (M = 3.56, SD = 2.99, Me = 2.00; $p = 0.003$), unofficial social media pages (M = 4.61, SD = 2.13, Me = 5.00; $p = 0.015$), and official government accounts (M = 4.93, SD = 2.18, Me = 5.00; $p = 0.012$). A similar pattern was found for users of medical databases and published research (M = 6.00, SD = 2.88, Me = 7.00), who exhibited significantly higher anosmia knowledge than those who used WhatsApp (M = 2.20, SD = 2.28, Me = 2.00; $p = 0.009$), Google News (M = 3.56, SD = 2.99, Me = 2.00; $p = 0.005$) and unofficial social media pages (M = 4.61, SD = 2.13, Me = 5.00; $p = 0.047$). There was also a some noted non-significant difference in anosmia knowledge between users of medical databases (M = 6.00, SD = 2.88, Me = 7.00) and users of official government accounts (M = 4.93, SD = 2.18, Me = 5.00; $p = 0.082$).

With regard to the PPE index, students who used Google News (M = 1.69, SD = 1.49, Me = 1.00) as an information source scored significantly lower than students who used medical databases (M = 3.49, SD = 1.91, Me = 4.00; $p = 0.03$), international organization's websites (M = 3.79, SD = 1.72, Me = 5.00; $p = 0.002$), and official government accounts (M = 3.29, SD = 1.96, Me = 4.00; $p = 0.025$). No significant differences were found for the treatment index.

Knowledge Level

Respondents who assessed their knowledge of COVID-19 as low (M = 1.80, SD = 0.40, Me = 2.00) exhibited significantly lower knowledge of common symptoms compared to students who stated that they had complete (M = 1.95, SD = 0.22, Me = 2.00; $p = 0.001$) and partial (M = 1.96, SD = 0.21, Me = 2.00; $p < 0.001$) knowledge. Students who claimed to have a complete level of knowledge on COVID-19 (M = 6.03, SD = 2.17, Me = 6.00) exhibited significantly higher knowledge of anosmia than

TABLE 2 | Frequencies and percentages of answers.

	Strongly agree	Agree	Don't know	Disagree	Strongly disagree
Common symptoms knowledge index					
Q7. COVID 19 Symptom of Fever	394 (79.8%)	98 (19.8%)	0 (0.0%)	0 (0.0%)	2 (0.4%)
Q8. COVID 19 Symptom of Cough	332 (67.2%)	132 (26.7%)	10 (2.0%)	18 (3.6%)	2 (0.4%)
Anosmia/dysgeusia knowledge index					
Q9. COVID 19 Symptom of Smell loss	219 (44.3%)	158 (32.0%)	99 (20.0%)	16 (3.2%)	2 (0.4%)
Q10. COVID 19 Symptom of Taste Changes	149 (30.2%)	159 (32.2%)	138 (27.9%)	40 (8.1%)	8 (1.6%)
Q11. COVID 19 Symptom of Smell Change Frequently Associate with Nasal Obstruction	58 (11.7%)	144 (29.1%)	224 (45.3%)	56 (11.3%)	12 (2.4%)
Q12. COVID 19 Symptom of Loss of Smell Commonly Associate with Sever Covid19 Cases	24 (4.9%)	74 (15.0%)	213 (43.1%)	154 (31.2%)	29 (5.9%)
Q13. Symptom of Loss of Smell Has been added as Criteria for COVID 19 Diagnosis	103 (20.9%)	140 (28.3%)	223 (45.1%)	23 (4.7%)	5 (1.0%)
Q14. Sudden Loss of Smell Mandate Isolation	134 (27.1%)	148 (30.0%)	150 (30.4%)	53 (10.7%)	9 (1.8%)
Q15. Any Patient with Isolate Sudden of Smell Loss Recommended to be Screen for COVID19	166 (33.6%)	186 (37.7%)	103 (20.9%)	36 (7.3%)	3 (0.6%)
Q17. Majority of Patient recovered their smell	153 (31.0%)	171 (34.6%)	156 (31.6%)	12 (2.4%)	2 (0.4%)
Q18. Majority of Patient complains of smell loss after been diagnosed with COVID19	20 (4.0%)	84 (17.0%)	234 (47.4%)	131 (26.5%)	20 (4.0%)
Personal protective equipment knowledge index					
Q19. Wearing N95 Mask During Contact with Patients with Sudden Smell Loss Secondary to COVID19	272 (55.1%)	103 (20.9%)	85 (17.2%)	26 (5.3%)	8 (1.6%)
Q20. Wearing Face Shield During Close Contact Examination	244 (49.4%)	93 (18.8%)	111 (22.5%)	33 (6.7%)	13 (2.6%)
Q21. Wearing Body Gown During Close Contact	242 (49.0%)	91 (18.4%)	102 (20.6%)	37 (7.5%)	22 (4.5%)
Q22. Wearing Shoes Cover During Close Contact	183 (37.0%)	92 (18.6%)	134 (27.1%)	50 (10.1%)	35 (7.1%)
Q23. Wearing Head Cover During Close Contact	215 (43.5%)	91 (18.4%)	117 (23.7%)	46 (9.3%)	25 (5.1%)
Treatment option knowledge index					
Q24. Smell Training Programme is Recommended for Smell Loss	88 (17.8%)	81 (16.4%)	289 (58.5%)	35 (7.1%)	1 (0.2%)
Q25. Nasal Steroid Spray is Recommended for Smell Loss	65 (13.2%)	100 (20.2%)	283 (57.3%)	35 (7.1%)	11 (2.2%)
Q26. Oral Steroid Spray is Recommended for Smell Loss	33 (6.7%)	46 (9.3%)	328 (66.4%)	67 (13.6%)	20 (4.0%)
Q27. Omega Supplement is Recommended	31 (6.3%)	51 (10.3%)	351 (71.1%)	48 (9.7%)	13 (2.6%)
Q28. Using Vitamin A Nasal Drops is Recommended	43 (8.7%)	65 (13.2%)	348 (70.4%)	31 (6.3%)	7 (1.4%)

participants with partial (M = 4.71, SD = 2.23, Me = 5.00; $p < 0.001$) and little (M = 4.13, SD = 2.50, Me = 5.00; $p < 0.001$) knowledge.

A similar pattern was found for the PPE index. Participants with a self-assessed complete level of COVID-19 knowledge (M = 3.72, SD = 1.80, Me = 5.00) scored significantly higher than

TABLE 3 | Gender comparison using *t*-test/Mann-Whitney *U*-test.

	Female			Male			*t/U*	*p*
	M	**SD**	**Me**	**M**	**SD**	**Me**		
Common symptoms	1.94	0.23	2.00	1.93	0.27	2.00	−0.49	0.622
Anosmia	5.02	2.28	5.00	5.08	2.36	5.00	0.24	0.812
PPE	3.67	1.85	5.00	3.08	1.97	3.00	23437.50	0.002
Treatment	1.09	1.35	0.00	1.32	1.46	1.00	25571.50	0.101

TABLE 4 | Frequencies for symptoms and triple index categorization in universities.

	Common symptoms index			Triple index		
	Poor	**mod.**	**Good**	**Poor**	**mod.**	**Good**
King Saud University	1 (1.2%)	8 (9.3%)	77 (89.5%)	65 (75.6%)	21 (24.4%)	0 (0%)
Prince Sattam Bin Abdulaziz University	0 (0%)	4 (4.8%)	79 (95.2%)	60 (72.3%)	17 (20.5%)	6 (7.2%)
Imam Muhammad ibn Saud University	0 (0%)	3 (8.1%)	34 (91.9%)	22 (59.5%)	11 (29.7%)	4 (10.8%)
King Saud bin Abdulaziz University for Health Sciences	0 (0%)	4 (6.5%)	58 (93.5%)	42 (67.7%)	17 (27.4%)	3 (4.8%)
Al Qassim University	0 (0%)	0 (0%)	56 (100%)	46 (82.1%)	10 (17.9%)	0 (0%)
King Khalid University	0 (0%)	8 (9.2%)	79 (90.8%)	66 (75.9%)	20 (23.0%)	1 (1.1%)
King Abdulaziz University	0 (0%)	3 (4.9%)	58 (95.1%)	50 (82.0%)	9 (14.8%)	2 (3.3%)
Other	0 (0%)	0 (0%)	22 (100%)	15 (68.2%)	6 (27.3%)	1 (4.5%)

those with little (M = 2.51, SD = 2.24, Me = 2.00; *p* = 0.004) and partial (M = 3.20, SD = 1.93, Me = 4.00; *p* = 0.024) knowledge. Finally, students who self-assessed as having complete knowledge of COVID-19 (M = 1.46, SD = 1.48, Me = 1.00) exhibited significantly higher knowledge of treatment in comparison to participants with self-assessed partial knowledge (M = 1.11, SD = 1.38, Me = 0.00; *p* = 0.041).

DISCUSSION

The current study aimed to determine the knowledge regarding COVID-19 common symptoms, anosmia (loss of sense of smell and taste), treatment options, and PPE among the medical students from three different universities. The findings revealed that majority of the participants had significant knowledge related to COVID-19 general symptom such as rise in body temperature, cough, and shortness of breath. However, only 35.6% participants were aware of anosmia (loss of sense of smell) as a specific symptom of corona disease. A viral infection is the most common cause of anosmia. Like other viruses, coronaviruses can result in anosmia in 10–15% of patients (14). COVID-19 infection differs from other coronaviruses in that the chemosensory dysfunction is more prevalent and is not associated with other rhinitis symptoms like nasal obstruction and rhinorrhea (11). There are growing evidence reported that loss of taste and smell is a strong predictor of COVID-19 infection (12). Having said that, in this study a 36.3% of participants did not know that change in taste or taste of eating as the symptom of the corona. One study reported that out of 6,452 confirmed COVID-19 cases, 64.76% experienced anosmia or ageusia (15). A possible pathogenesis for anosmia suggested

by Brann et al. (16) is that the COVID-19 virus affects the non-neuronal olfactory cells, causing loss of smell and associated taste alteration. Zhou et al. (17) confirmed that COVID-19 uses the cellular angiotensin-converting enzyme 2 receptor. Because this enzyme is distributed in the oral cavity, it is possible that the virus affects the taste function (17).

In terms of gender differences regarding the knowledge of symptoms, anosmia, treatment, and PPE. The findings revealed that female participants had significantly good knowledge (*p* = 0.020) on the use of PPE as compared to that male participants. However, there was no significant difference in the knowledge level of symptoms, anosmia and treatment between male and female participants. It contradicts the findings of a previously conducted study which states that showed that men had less knowledge of COVID-19 compared to women (18).

Overall, our study revealed that medical students in Saudi Arabia have good knowledge of common COVID-19 symptoms, regardless of their information source. The same finding was seen in two cross-sectional studies conducted in Jordan and Uganda, where the students showed a high level of knowledge (19, 20). The current study also revealed that no significant difference was seen when the knowledge was assessed based on college year or university affiliation. These findings might be explained by the awareness campaigns and education programs conducted by governments to target the whole community (18). Another factor that may explain these findings is the seriousness of the disease, especially after being declared a pandemic by the WHO (21).

Our findings show that the majority of the included participants were aware of common COVID-19 symptoms like fever and cough (79.8 and 67.2%, respectively), but less than half were aware that smell or taste dysfunction might be a symptom of

COVID-19 (44.3 and 30.2%, respectively). Because anosmia can be an early symptom of COVID-19, this lack of knowledge may delay the diagnosis of COVID-19 and thus increase the risk of infection spread (22).

In India, the health ministry proposed provisional permission of senior medical undergraduates to treat patients with COVID-19 (23). Medical students in the university hospitals are at risk of infectious diseases. Proximity to infected patients' respiratory droplets increases the risk of disease transmission (24). It has been shown that cooperation between hospitals and universities enhances medical students' knowledge of new infectious diseases and helps to improve their perceptions and preventive behaviors (25). Therefore, it is important to assess their knowledge of COVID-19 symptoms and preventive measures. To the best of our knowledge, this is the first descriptive study in this field among undergraduate medical students from all regions of Saudi Arabia.

The assessment of smell or taste dysfunction is not only helpful for diagnosing COVID-19 but also for triaging patients. In a previous study of 417 mild to moderate COVID-19 patients, 85.6 and 88.0% of patients reported olfactory and gustatory dysfunctions, respectively. Moreover, olfactory dysfunction appeared before the other symptoms in 11.8% of cases (22). Moein et al. (26) suggested that early quantitative smell testing, like the University of Pennsylvania Smell Identification Test, may help to identify COVID-19 patients in need of early treatment or quarantine. Interestingly, in our study, 150 participants (30.4%) were not aware that a sudden change in the sense of smell necessitates isolation and seeking medical help, and 62 participants (12.5%) disagreed with this statement.

The present study revealed that the source of information is also critical to the awareness of COVID-19 symptoms among medical students. We found that students using international organization's websites, medical databases, or published research had better knowledge of anosmia as a COVID-19 symptom compared to those who used WhatsApp, Google News, or unofficial social media pages. The Ugandan cross-sectional study mentioned above also found that although the majority of the students used mass media to obtain their information, those who also used journal articles and websites had significantly greater knowledge than the others (20).

There is widespread dissemination of misinformation in social media websites (27). However, in our study, a majority of participants relied on authentic governmental sources such as WHO and ministry of health websites for information regarding COVID-19. This was contradictory to the Jordanian and Ugandan studies, which revealed that social media was the main source of the students' information (19, 20). Although the CDC has recommended PPE for healthcare workers when dealing with suspected or confirmed COVID-19 patients (28), our study revealed that the students had a suboptimal level of PPE knowledge overall. We also found that participants who self-assessed as having a complete level of COVID-19 knowledge scored significantly higher than those with little or partial knowledge regarding the PPE knowledge index.

In their systematic review, Costa et al. (7) stated that there is still no scientific evidence of specific treatments for olfactory and taste disorders in COVID-19. They also showed that recovery generally occurs within the first 2 weeks after the resolution of COVID-19. Our study revealed that the majority of the participants were unaware of the treatment options described in the literature, and only 210 participants (42.5%) knew that recovery usually occurs within 2 weeks of resolution of the disease.

There are certain limitations to this study. Firstly, the study design was cross-sectional, which provides lower quality. However, a longitudinal study was not a feasible option with the current situation of social distancing and lockdown. The second limitation was convenience sampling. There is a potential risk of bias as the underprivileged populations may be ignored due to the lack of access to the social media platforms such as Whatsapp and Twitter. The findings of the current study are limited as it may not be the actual representative of the Saudi population. It can be addressed in the future studies through more systematic sampling method that ensures representativeness and generalization of the findings. The third limitation in the current study is related to study instrument. It has not been rigorously validated for the potential factors that influence knowledge, perceptions and attitudes of the participants. Some of the potential factors that might influence knowledge include health literacy and risk perception. Moreover, one another limitation was the possibility of participants to give false responses. It has been seen that in self-reported data the participants strive to give socially desirable responses. Therefore, the data may not be the true representation of the knowledge, attitude and practices regarding the COVID-19 symptoms.

CONCLUSION

The present study revealed good knowledge of COVID-19 symptoms among medical students in Saudi Arabia. Additionally, it was found that Saudi medical students understand that smell or taste dysfunction can be a potential symptom of COVID-19, but this knowledge was not as widespread as the knowledge regarding the most common COVID-19 symptoms, such as fever and cough. Universities need to enhance the knowledge of COVID-19 among medical students and prepare them for safe practice once needed.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Prince Sattam bin Abdulaziz University. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

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Attitude, Perception, and Knowledge of COVID-19 Among General Public in Pakistan

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The World Health Organization has acknowledged coronavirus disease 2019 (COVID-19) disease as a pandemic. Efforts are being made all over the world to raise awareness to prevent the spread of the disease. The goal of this study was to assess the attitude, perception, and knowledge of Pakistani people toward COVID-19 disease. We conducted a cross-sectional survey in which a questionnaire of 17 questions was transformed online on Google forms and was sent to random individuals online. A total of 1,000 questionnaires from individuals throughout Pakistan were evaluated. The results revealed that 42.9% of the participants knew about COVID-19 through social media, the largest source of information. Most of the participants (48.3%) started working from home amid the lockdown; 39.9% of the participants reported that they wash their hands every hour, and 56.9% participants are using a surgical mask. About thermal scanners, 30.5% of the people answered they may be effective, and 46.0% of the people think COVID-19 is a bioweapon; 59% of the participants think everyone is susceptible, whereas 83.9% of the people recognize fever as a primary symptom; 65.2% of the people are practicing social distancing, whereas 85.1% of the people think social gatherings causes spread of the disease. In general, participants had a good knowledge about the disease and a positive attitude toward protective measures. The effective measures are being taken by the government and the public; still, there remains a need for further awareness campaigns and knowledge of safe interventions to combat the spread of disease.

Keywords: knowledge, perception, awareness, behavior, practices, public, COVID-19, Pakistan

INTRODUCTION

At the time when the whole world is fighting against the brisk irrepressible coronavirus disease 2019 (COVID-19), assessing the perception of a relevant population regarding necessary safety measures and their way of dealing with such a situation can help in better understanding of people's psychology. It will assist in better understanding of methodologies to counsel them in a way that leads to general public safety besides restraining the spread of the disease (1). Education programs regarding mental well-being via various communication platforms have been conducted vastly during the current breakout for ordinary people and health care professionals (2). By February 8, 2020, 29 books regarding COVID-19 were published, of which 11 were related to the mental

well-being of people including a book for counseling and self-safety against COVID-19 publicized by the Chinese Association for Mental Health (3).

Household surveys based on the compact segment or grid-based geographical information system sampling usually take weeks to months to complete (4). Phone-based surveys have widely been conducted since 1980, but people's communication methods have changed a lot since then; for example, Gallup Poll Social Series received only a 7% response rate via phone in 2017 (5). Keeping these limitations in mind, rapid online surveys are reasonably easy to conduct and get completed fast compared to other conventional survey methods. The online survey also demands minimum human resources, besides those needed for preparing a questionnaire, to reach a vast range of respondents in a minimum period and also allow continuous survey monitoring (6). Thus, it can be considered as a powerful tool to collect information in such a global outbreak situation.

The COVID-19 that was declared a pandemic by the World Health Organization (WHO) on March 13, 2020, after the widespread of the disease in Europe, and the drastic number of deaths in Italy is exceptionally transmissible (7). The current scenario has shown quite a noticeable impact on people's mental well-being besides their physical well-being. It has changed their perception about life, and their priorities regarding daily life routine have also been affected (8). Such a global situation can only be controlled with people's consent to behave in a particular manner instructed by health care providers such as frequent hand washing, using the facemask, avoiding gatherings, and maintaining permissible distance (9).

Another factor that needs to be tackled is misconceptions related to the disease besides the disease itself—keeping into consideration the given fact, WHO has designed a particular page named "myth buster" to tackle such misconceptions, which are even more harmful than the disease itself. Such outbreaks have always been accompanied by a tsunami of misinformation and misuse of drug therapies (10). However, in an era of fast communication technologies, such misconceptions get amplified and spread at a pace faster than the real facts through social media. Such fake pieces of information and concepts could be drastically damaging for the general public who blindly follow any information they get to run for safety (11).

In a study conducted in China, most people (60.81%) who spent 20–24 h at home did not show signs of the disease, and very few contacted any patients with COVID-19 history. Internet was the primary source of health-related news updates for these people. Almost 90% public asked for regular information update regarding ways of disease transmission, preparation on new medications for the disease, precautionary measures to be kept in focus while traveling, ways other countries are handling the pandemic, areas more affected by the virus, and related details. Almost 70% population was appeased with details regarding health care provided to them. More than half of the population used to wash their hands regularly with soap and used facemasks as a precaution regardless of assessing the presence of the disease symptoms in them (12).

This rapid survey was designed to determine knowledge, attitude, and perceptions of COVID-19 among educated general public in Pakistan. The in-depth analysis was carried out through online assessment to better understand the knowledge and risk perception about COVID-19 outbreak in Pakistan.

METHODOLOGY

A questionnaire was designed, keeping into consideration the prevalent attitudes and beliefs of the general public of COVID-19. Some past guidelines were kept into consideration while designing the questionnaire (13). The form was first assessed by a few healthcare professionals from various domains. The corrections and adjustments were made as per their suggestions. The grammatical errors were corrected using Grammarly by adjusting the goals of questions according to audience, formality, domain, tone, and intent. The audience and domain were selected as "general," whereas the formality, tone, and intent were adjusted as "neutral," "analytical," and "describe," respectively. The form was then distributed among 20 participants, and their feedback was taken. This was to evaluate how each participant perceives the question. Their feedback, if any, was also taken into consideration to make any change to the questionnaire.

The questionnaire was then transformed online on Google forms and was sent to random individuals online (e-mail, WhatsApp, and Facebook groups). A total of 2,000 individuals were invited to fill the questionnaire throughout Pakistan, including Azad Jammu and Kashmir. The e-mail address was a mandatory field to contact an individual in case of any confusion. The header of the form reads the consent policy, and the objectives of the study were made clear. The participation was completely voluntary. The participants may leave the form any time without submitting the form. The form was kept open for 10 days, and no responses were accepted after it. The first question requires the participant to disclose their English fluency. Since English has been the official language of the country, it is not widely used and understood by the general public. Anyone who responded non-fluency in the English language was eliminated from the study.

Similarly, the second question asked the individuals whether they heard of COVID-19 or 2019-nCoV or coronavirus disease in 2019. Those who answered "no" to this question were also excluded from the study. All other responses were accepted. All the questions in the form were mandatory except for the name of the participant.

Statistical Analysis

The results were exported from Google forms and saved in CSV format. MS Excel 2013 and SPSSv21 were used to evaluate data. The results were expressed as mean, median, interquartile ranges (IQRs), and percentages. A χ^2 test was applied to assess any correlation between categorical variables.

RESULTS

A total of 1,159 responses were received, making a response rate of 57.95% response rate. Of them, 30 participants (2.59%) disclosed that they do not have fluent English and were eliminated. One hundred nine participants (9.41%) had never

heard of COVID-19. Twenty (1.73%) responded that they do not have fluent English, and they had never heard of the disease. These individuals were also excluded from the study. Hence, only 1,000 responses were evaluated throughout the study. Of these, 62.1% (621) of the sample population were males, and 37.9% (379) were females. The mean ± standard deviation and median (IQR) age of the participants were 25.39 ± 6.07 years and 24.0 (21.0–29.0) years, respectively.

Demographic Details of the Respondents

Figure 1 given below show the demographic characteristics, i.e., age, gender, area of residence, education, occupation, and total household income of the respondents who filled the online survey: age: the maximum number of people were between the age of 18–27 years (68.4%); gender: 62.1% of males and 37.9% of females participated in the study; area of residence: most people who participated in the study were from Punjab (46.6%) and minimum from Baluchistan (2.1%); education: a majority of the population (55.9%) was bachelor or professional degree holders, followed by master's degree holders (19.1%) and a minimum number of people were below the matriculation level (0.3%); occupation: mostly, students (35.3%) and professionals from the health sector (32.0%) filled the online survey; and total household income: the majority of people (25.6%) who participated in the study have a household income between 40,000 and 59,999 PKR.

Attitudes, Behavior, and Perceptions About COVID-19

The behavior and attitude of people toward the COVID-19 pandemic play an essential role in its spread, and according to our survey, more than three-fourths of the respondents knew about through social media (42.9%) and electronic media (41%). A small number of people had direct exposure (6.2%), and the least people came to know about it through print media (1.2%). The people who had jobs were inquired about their work handling, and nearly half of the respondents (48.3%) were working from home. Followed by that, there was a complete shutdown of work for those who had businesses (21.7%), and a small number of respondents continued their job as before (20.1%).

When asked about their social distance practices (65.6%), people responded that they have not been to any gatherings at all, while 3.6% responded they have been to gatherings many times. Upon inquiring about their hygiene habits and hand-washing frequency as directed by the health care professionals, the majority of people responded that they washed their hands after every hour (39.9%), followed by those who washed them few times a day (35.3%), and 1.6% said that they do not wash their hands.

Using a mask during the COVID-19 outbreak has been advised by the health care professionals, and upon asking which mask did the participants of our study use as a preventive measure, more than half of them (56.9%) used the surgical mask, followed by cloth mask (18.0%) and N95 mask (6.3%). People who did not use masks were 17.8%, and 1% of the participants did not know about it. The perception of people toward thermal scanners showed that a small percentage of people (24.8%)

considered them useful, whereas 30.1% thought it is not an effective way of scanning for the virus.

There has been much debate about COVID-19 being a bioweapon or not, so we asked this from the participants of our study, and 46% think it is a bioweapon, and 42.6% think it is not. Only 11.4% responded "maybe" toward this question. The responses are recorded in **Table 1**.

Knowledge of COVID-19 Among Participants

The participants had sensibly well knowledge about the diseases, and 83.9% recognized fever, 80.8% recognized cough, and 68.6% recognized shortness of breath as the three main symptoms of COVID-19. Upon asking, 59.0% responded that everyone is susceptible to this disease. About two-thirds of participants responded that the most effective way of controlling the disease is social distancing (65.2%) and frequent hand washing (63.8%). More than half of the respondents (54.4%) stated that using masks as directed by health care professionals is effective in disease control, and approximately 45.0% responded that avoiding sick people is also an effective preventive measure toward COVID-19. Overall dietary habits and lifestyle were also inquired. The response from 35.6% was that eating fruits with vitamin C is an effective in the prevention of COVID-19, followed by taking steam (responded by 23.5%), rinsing the nose and doing gargles repeatedly (23.2%), taking honey, black cumin, and garlic (16.8%), taking green tea (14.8%), exposure to the sun (8.4%), pneumonia vaccine shot by 3.4%, and taking antibiotics was responded by 1.9% of the participants.

We asked the common causes of transmission of the disease, and 85.1% responded to social gatherings, and 69.2% of the participants thought that the handshakes are the main culprits in the spread of the disease. Handling banknotes and currency were also responded as a positive mean by about half of the participants (46.4%). In comparison (40.4%), people answered that not maintaining a distance of at least 6 feet can cause transmission of the disease. Other frequently touched items can also be the cause of spreading the diseases, and upon asking, 35.2% thought doorknobs, 22.8% through mobile phones, 15.0% thought used gloves and masks, and 6.8% thought clothes are a mode of transmission of COVID-19 virus among the population. The responses are recorded in **Table 2**.

Relationship Between Participants' Demographic Characteristics and Their Responses

Associations of different characteristics were made against the participants' knowledge of COVID-19. First, education levels of the participants were evaluated against the use of mask by the participants. It was observed that the use of make was significantly less among individuals with lower education levels as compared to individuals with higher education ($P < 0.05$). However, non-significant relationships were present between education level and other aspects of our study such as attending social gatherings, frequent hand washing, and COVID-19 as a bioweapon. Second, income levels of the participants were
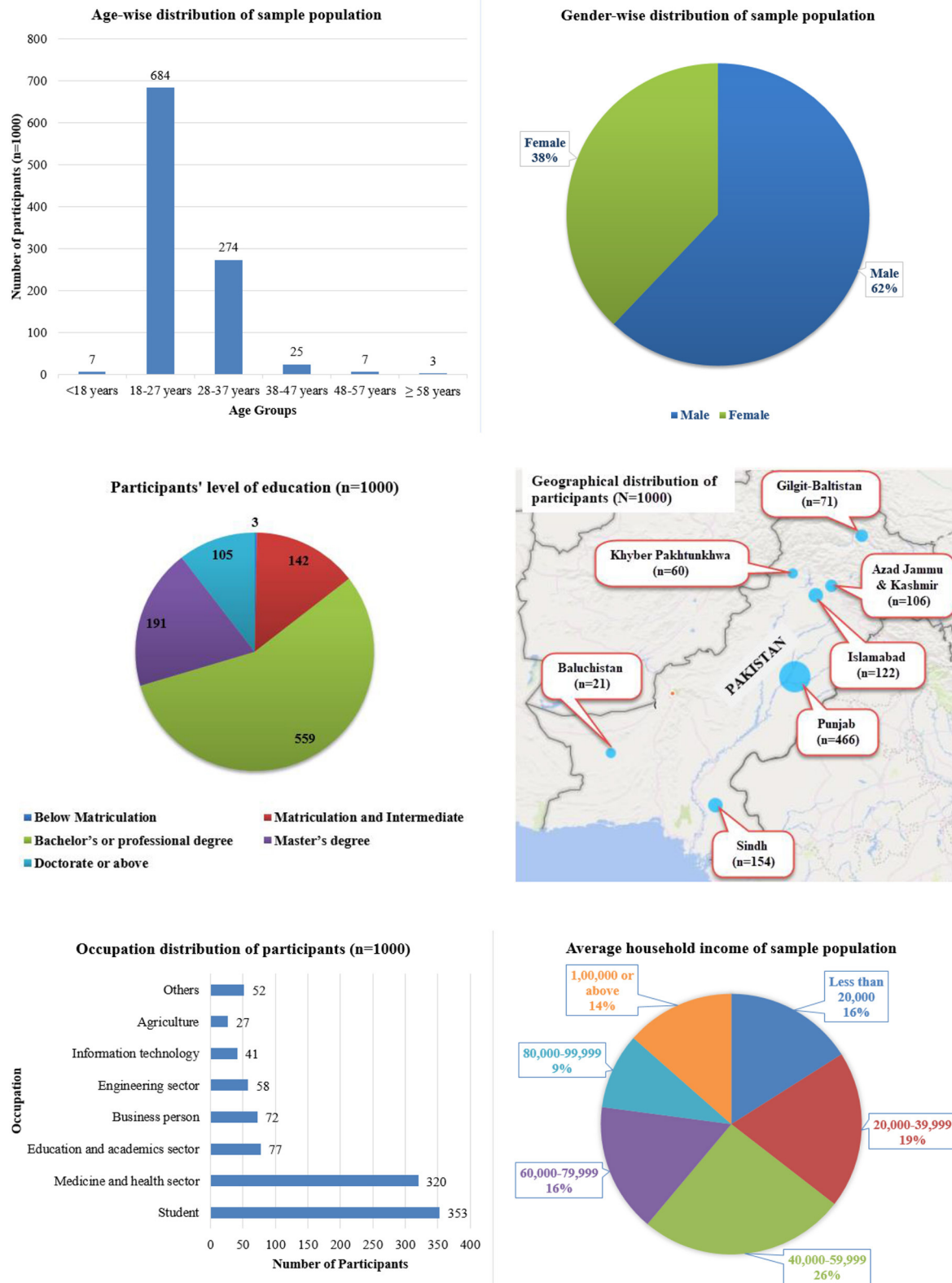
FIGURE 1 | Demographic features of the participants.

TABLE 1 | Attitudes, behavior and perceptions about COVID-19.

	n (%)
How did you come to know about COVID-19?	
Social Media	429 (42.9%)
Electronic Media (TV/Radio)	410 (41.0%)
By Family or Friends	87 (8.7%)
Direct Exposure	62 (6.2%)
Print Media (Newspaper/Articles)	12 (1.2%)
How are you handling work during this outbreak?	
Working from home	483 (48.3%)
Business is completely shut down	217 (21.7%)
Continuing job as before	201 (20.1%)
Left job for my safety	99 (9.9%)
Have you been to gatherings since then?	
Many times	36 (3.6%)
A few times	212 (21.2%)
Once	96 (9.6%)
Not at all	656 (65.6%)
How often do you wash your hands as stated by health professionals?	
After every half hour	232 (23.2%)
After every hour	399 (39.9%)
Few times a day	353 (35.3%)
I don't wash them	16 (1.6%)
What type of mask do you use?	
Surgical Mask	569 (56.9%)
Cloth mask	180 (18.0%)
N95 mask	63 (6.3%)
I do not use a mask	178 (17.8%)
I don't know	10 (1.0%)
Are thermal scanners effective in detecting patients with corona-virus?	
Yes	248 (24.8%)
May be	305 (30.5%)
Only if patient has fever	215 (21.5%)
No, it is not 100% effective way of detection	231 (23.1%)
Do you think COVID-19 is a bioweapon?	
Yes	460 (46.0%)
No	426 (42.6%)
May be	114 (11.4%)

TABLE 2 | Knowledge of COVID-19 among participants ($n = 1,000$).

Who is more likely to get infected with coronavirus?	
Everyone is susceptible	590 (59.0%)
Old age	443 (44.3%)
Infants and Children	204 (20.4%)
Adults	30 (3.0%)
I don't know	14 (1.4%)
Symptoms indicating that patient is infected with coronavirus?	
Fever	839 (83.9%)
Cough	808 (80.8%)
Shortness of breath	686 (68.6%)
Flu	436 (43.6%)
Body pain	227 (22.7%)
No symptoms	203 (20.3%)
Stomach problem	32 (3.2%)
Skin rash	23 (2.3%)
Nose bleed	18 (1.8%)
Effective measures for controlling COVID-19?	
Social distancing	652 (65.2%)
Frequent hand washing	638 (63.8%)
Using masks and gloves	544 (54.4%)
Avoid contacting sick people	450 (45.0%)
Avoid touching face	392 (39.2%)
Eating fruits with Vitamin-C	356 (35.6%)
Taking steam	235 (23.5%)
Rinsing nose and doing gargles repeatedly	232 (23.2%)
Taking honey, black cumin, and garlic	168 (16.8%)
Taking green tea	148 (14.8%)
Exposure to sun	84 (8.4%)
Pneumonia vaccine shot	34 (3.4%)
Taking antibiotics	19 (1.9%)
Most common causes of coronavirus transmission?	
Social gatherings	851 (85.1%)
Handshakes	692 (69.2%)
Money or bank notes handling	464 (46.4%)
Standing at 6 feet distance	404 (40.4%)
Door knob and handles	352 (35.2%)
Mobile phones	228 (22.8%)
Used gloves and masks	150 (15.0%)
Clothes	68 (6.8%)

analyzed against various factors. A significant relationship was found among the income level of the participant and their affinity to join social gatherings during the COVID-19 pandemic. It was observed that respondents with lower income levels were more likely to attend gatherings as compared to higher-income respondents. Similarly, income level was also found to be associated with the subjects' use of mask. Participants with higher income levels were wearing N95 and surgical masks, whereas cloth masks were usually used by lower-income respondents. Terminally higher- and lower- income category subjects wore fewer masks as compared to middle-income-range groups. More participants in the lower-income category had to leave their jobs or had their business shut down during the COVID-19 pandemic as compared to higher-income respondents. Likewise, more women have left their jobs as compared to their male counterparts. However, business shutdown trend mainly affected the male gender. Male respondents were gathering more frequently as compared to the females ($P < 0.05$). Moreover, the males were found to wear mask more often than the females. Females usually wore N95 masks, whereas male respondents relied more on surgical masks or cloth masks. On the contrary, no significant associations were present among all the characteristics with hand-washing practices and the use of COVID-19 as bioweapons (**Table 3**).

Sr. No.	Demographic characteristics	Attitudes of respondents	p-Value
1	Education level	Use of mask	<0.05
		COVID-19 as bioweapon, gatherings, hand washing	>0.05
2	Income level	Gatherings, type of mask, work status	<0.05
		Hand washing, COVID-19 as bioweapon	>0.05
3	Gender	Work status, gatherings, use of mask	<0.05
		Hand washing, COVID-19 as bioweapon	>0.05

Pearson Chi-square test was applied and values were significant (p < 0.05).

DISCUSSION

The in-depth analysis of perceptions and knowledge of COVID-19 was carried out through online assessment among the general public of Pakistan. It took only 10 days to obtain 1,159 responses of knowledge and a perception-based questionnaire containing 17 questions, of which responses of 1,000 adults were analyzed. It appears from the results that most of the participants came to know about the disease COVID-19 or SARS-CoV-2 through social and electronic media. Although these platforms are a natural source of access to the information and data around the world, it is still not the most reliable option to choose from. Fake news is often associated with such platforms as Facebook. For example, there had been much misinformation about the hydroxychloroquine to be used as a potential treatment for the COVID-19, which caused a shortage of that drug for those who actually needed them (14). The demographics of the participants, like age, sex, and ethnicity, indicated that most active participation was seen from male adults of Punjab province. The distribution of participants among education and household income showed that people came from mediocre but educated families. It might be due to the reason that Punjab is concentrated in population and has the highest literacy rate among other provinces (15); therefore, most people were able to respond to an online assessment survey form. The highest number of responses indicates the quality of the study was obtained by students mostly holding a professional or master's degree and health or medical professionals. This means that they carefully evaluated and answered the questions based on pertinent information. A similar trend was observed in a survey-based study among students of China (16).

Regarding the survey findings, the participants are observing social distancing and hand washing quite frequently. The general public appeared to have a compliant attitude toward the precautions to be taken for COVID-19 (17). The participants all over the region believe that typical surgical masks are most effective in protecting them from the COVID infection, and

they overestimated the protective ability of a cloth mask over an N95 mask. In a similar study performed in Egypt, the general public seemed to believe that wearing a mask will save them for virus infection, but they do not know which mask is active (18). The WHO has not recommended that healthy people should wear masks; however, if someone is experiencing symptoms of the respiratory disease, which could possibly be a SARS-CoV-2 infection, they must wear an N95 mask for protective purposes (19). Thermal scanners are also being used at the grocery stores and banks, which are open in Pakistan during the pandemic, and a very few people responded that it might be an effective mean of scanning for COVID-19–positive patients. Likely as a result of this perception, it looks like even the educated people do not put their faith in the effectiveness of thermal scanners. However, it has been reported in the literature that thermal scanners have been used as an effective strategy at hospitals (20) and airports (21) for the screening of SARS-CoV-2 infection, and they have proven helpful.

There is a controversy about COVID-19 plague being a bioweapon, and according to our survey, almost half of the participants responded "yes," and half of them responded "no," whereas a small percentage responded, "maybe." The results interestingly show that the perception of people equally supports both notions, i.e., COVID-19 being a natural pandemic or a possible bioweapon. The results are comparable to a study where the researchers explain how this infection has virtually created a downfall to the superpowers of the world by putting the entire world in quarantine and devastating the global economy (22).

In our collected responses, majority participants thought that everyone is susceptible to the novel coronavirus disease, while nearly the same number of participants responded that older people are more likely to get it. The results are similar to a Chinese study, which provides information about the COVID-19-affected people (23). The COVID-19 infection may be symptomatic or asymptomatic in many people; however, according to the result of our survey, the participants have recognized fever, cough, and shortness of breath as three primary symptoms of the infected person. The knowledge of our participants is in line with those presented by other epidemiological studies (23, 24).

The most crucial thing in a contagious disease is to be cautious of its mode of transmission and valid measures of its prevention. The participants in our survey have largely responded that social gatherings and intimacy such as handshakes are the leading cause of the spread of the SARS-CoV-2 infection, and the key to preventing and containing it is also in practicing social distancing and frequent hand washing. These responses show that the knowledge of the participants is up-to-date and in accordance with the guidelines of WHO (25, 26). We can relate the knowledge and perception of Pakistani people to Chinese containment of the COVID-19. They practiced control measures such as limiting social gatherings by shutting down cities and limiting the traffic throughout their country. They had confidence in winning the battle against coronavirus, so they used these measures wisely and were able to control the disease effectively with a low mortality rate (23).

The COVID-19 pandemic causes a huge global health crisis and impacts on large-scale behavior and attitude changes of the public (1). Proportion of asymptomatic patients in case of COVID-19 is high and an important feature of this disease. It is estimated that approximately 60% of all infections with mild symptoms or asymptotic cases might pass the virus to others (27). With the increasing number of COVID-19 cases globally, different countries including Pakistan have adopted precautionary measures, i.e., social distancing, frequent hand washing, and wearing mask to prevent its spread. Wearing facemask is an effective physical intervention against disease transmission (28). The use of facemasks has become extensive in developed and underdeveloped countries including Asia. Most of the people are using simple surgical mask to reduce the risk of getting COVID-19 infection (29). Public perception of health risk plays a vital role in the adoption of government measures to prevent spread of COVID-19, and these measures and actions had direct influence on lifestyles and attitude of people (30).

Limitations and Strengths

This study is among a few studies that were conducted to evaluate the attitude, perception, and knowledge of general public regarding COVID-19. A huge number of participants took part in this study. As the study was conducted during lockdown, an online questionnaire was used for assessment. The study was limited to only those individuals who were able to read and write English language. Another limitation of this study was that most of the responses we received were from educated section of society who have access to the internet, and the rest of the public was hence excluded. A large number of respondents in this study were linked to various healthcare professions; therefore, this study may also have exhibited good knowledge of disease among participants. Unfortunately, the study may not have exactly represented all the proportions of our current society; however, it may reflect a general overview of the behaviors present in the society.

Because of limited representation of the participants, more studies like this are suggested to investigate other areas related to COVID-19 in Pakistan such as the economic burden and availability of the SARS-CoV-2 vaccines in the residents of low socioeconomic status. Our study was limited to the people who understand the English language. Furthermore, most of the respondents have a medical background, so the knowledge and behavior of these individuals affect the overall study results.

However, some recent studies have shown similar results as those of our study. In one study, it was shown that there is a high-level knowledge regarding the disease among the participants. But some myths are also prevalent among the public (31, 32). Such gaps need to be addressed in the education and awareness programs for better response toward COVID-19 (33).

CONCLUSION

In summary, the findings of our survey suggest that the Pakistani residents of a relatively mediocre socioeconomic status, particularly men and students with a medical background, have appropriate practices and optimistic approaches due to the peak of a COVID-19 infection period. Different opinion lies among each gender regarding the perception of COVID-19. The education and health programs have aimed at improving the knowledge of the general population about COVID-19, and they are maintaining safe practices and optimism in people's attitudes.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/supplementary materials, further inquiries can be directed to the corresponding author/s.

ETHICS STATEMENT

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. The patients/participants provided their written informed consent to participate in this study. Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

AUTHOR CONTRIBUTIONS

SM and FM conceived and written the manuscript. TH did final review and approved the manuscript. MA did statistical analysis and manuscript writing. AM designed the manuscript and did data collection. BB and SA compiled results and editing of manuscript. All authors contributed to the article and approved the submitted version.

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Restructuring the Healthcare System to Protect Healthcare Personnel Amidst the COVID-19 Pandemic

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INTRODUCTION

COVID-19 infection caused by SARS-CoV2 has been declared a pandemic by the World Health Organization. Reports from China and France have shown that older age is a prognosticator of severity and mortality (1, 2). The number of elderly COVID-19 cases and the increased death rates among them compared to the younger population are surfacing across the world. The odds of hospitalization and the requirement of ICU facilities for the elderly are very high, which further adds burdens to the already compromised system in India where 0.55 beds are available per 1,000 of the population (3). ICU care is also very low, which aggravates the situation (3). Data from other countries have shown that even though 20% of cases are elderly people, they account for 79% of deaths, since associated comorbidities like diabetes, hypertension, respiratory diseases, which are common in the older population, fan the flames (4–6). A model-based analysis from China demonstrated a compelling age gradient in the case of fatality ratio 0.32 in < 60 years vs. 6.4% in >60 years and up to 13.4% in >80. Analogously, the hospitalization rate in infected individuals also upsurges with age (7). A study done from China analyzed data from 27 countries and highlighted age as the most important predictor for the odds of surviving from COVID-19 disease (8).

In Wuhan, more than 3,300, and in Italy 4,800, front line medical staff were infected[1]. In China, out of the total overall deaths, 4.4% were health care workers and the median age was 55 years (9). Likewise in the USA, where 9,282 cases were reported among health workers and the median age was 42 years and 74.5% were female[2]. In Indonesia, 115 doctors had died because of COVID-19 as of September 2020 (10). The rate of infection among doctors in India is very high in comparison to other countries. As of late September 2020, 2,238 doctors have been infected and around 380 have died due to coronavirus, with 75% of them above the age of 50 years (11, 12). In the UK, mortality was higher among Black and Asian doctors (13). This vulnerability varies across ages and states. Across the world, the majority of the healthcare workforce is above 50 years of age[1] and they are at high risk of being infected, owing to their nature of work (14–16).

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[1] https://www.theguardian.com/world/2020/apr/16/doctors-nurses-porters-volunteers-the-uk-health-workers-who-have-died-from-covid-19.

[2] https://www.cdc.gov/mmwr/volumes/69/wr/mm6915e6.htm.

A single surgery or procedure could risk infecting multiple healthcare staff at the same time (17). Those who get infected may not develop symptoms themselves but can transmit the infection to colleagues or patients because of interaction in enclosed spaces, creating a causal nexus (18). Infected healthcare staff often go into quarantine or require hospitalization. As the number of beds and staff is already low, this shortage further strains the healthcare system and it is not easy to train new staff in a short period (19). Lack of testing facilities, shortage, and low-quality PPE has made the situation worse (20). Although the Indian government has relaxed leaves rules for staff above 50 (21), there are still not been any clear policies or guidelines for health staff above 50 years of age on protecting them from infection and other complications due to COVID-19. Prevention from infection does not only require masks and PPE, it also calls for measures and the restructuring of administration, engineering, and academia (22–24).

Public health care services, which are the lifeline of any country, need to be rejuvenated. In the current pandemic, effective public healthcare system models like Bhilwara, South Korea, and Kerala were able to control COVID-19 due to the implementation of intensive outreach based public health measures like contact tracing, case identification, home-based screening, home quarantine, and the restriction of movement (25). It has been observed that during this pandemic situation, most COVID-19 cases are being treated in public hospitals (26). Therefore, to enhance the scalability, sustainability, and build the resilience of public health systems in similar future unprecedented events, the gross domestic product needs to take a quantum jump from 1.15 to 4–5% and create robust public health systems and achieve universal health coverage (27).

Keeping the current situation in mind, the restructuring of health systems is needed and it may be prudent to recommend that only a younger, fitter, and robust health care force are at the forefront of care until more promising prevention strategies, such as a vaccine, have been developed. Another crucial approach is to reverse quarantine and urge senior healthcare staff to stay at home and provide guidance virtually, to limit their exposure to the virus (28, 29). Junior doctors such as post-graduate residents and interns should be allowed to run frontline health services and develop a deeper skillset (30). For instance, the operation theaters and emergencies could be managed by junior staff under the leadership of more senior staff. Seniors should be encouraged to work in non-clinical areas where the risk of infection is low. In this context, virtual rounds that take information from residents could be the new normal (31).

Periodic surveillance of all the health care workers for early detection and treatment of the virus is required. This will also help break the chain of transmission. Stanford tried weekly testing of staff (32). Regular webinars on stress management for healthcare professionals working in this high-stress environment may also be required. Instead of seeing the current situation as a challenge, it is time to take the opportunity to transition to a digitalized health system, removing implementation barriers, and investing in telehealth, which will bear fruit in the long term as a way of extending reach and impact, and simultaneously helping to accomplish Sustainable Development Goal 3 (33).

Every hospital should have a dedicated disaster committee or pandemic preparedness taskforce. A human resource management committee focusing on the duty schedule could provide support to family members of health workers. SMART roster policies of staff in COVID-19 wards (1 week of duty with 2 weeks of isolation) and the same individuals during isolation could support frontline teams virtually using technology. The deployment of a younger healthcare workforce including junior doctors and paramedics in outreach services in the community will decrease the burdens on resources such as PPE, beds, and ventilators and the risk of contagion in tertiary care. Strengthening the capacity and skills of medical and other frontline sectors is crucial in the current panic situation, and could be done virtually by senior health care workers (34). Telemedicine is needed to accelerate the curve of quality education and access to services whilst concomitantly flattening the curve of the epidemic (35).

Health care workers have greater exposure to severe disease patients. Surgeries and other aerosol-producing procedures like intubation, endoscopy, and resuscitation, etc. put them at higher risk of contracting the virus (36). The occupational hazard risks are not fully understood but generate the need for a tool to stratify healthcare workers at higher risks. Hence there is an urgent need to develop risk scores for deciding roles and duties. Such scoring should be based on age, presence of comorbidities (Heart disease/lung disease/diabetes/kidney disease/weak immune system), pregnancy, disability, training status, and family support, etc. (8, 37). The formulation of proper guidelines and checklists to control errors will be useful. Regular training audits and mock drills should be part of the system. Regular simulation modeling techniques should be used and will help in predicting the outcome of each measure.

The biomedical waste management, laundry, and housecleaning departments must be engaged in all infection control meetings (38). In Intensive care units, preprocedural briefings and post-procedural debriefings should be made mandatory. Patient zoning and flow should be managed strategically. It has been demonstrated that clinical triage tools to cohort and isolate the virus, potentially reducing the chances of hospital-acquired COVID-19 infection (39). The establishment of a separate triage building that would serve the purpose of efficient triage of patients should also be considered (40). The whole hospital can be divided into separate suspected COVID-19 zoned building and a non-COVID-19 building. A patient who does not fit any criteria of suspected COVID should only be referred from the triage building to the Non-COVID-19 building and the rest should be treated in the suspected COVID-19 building. Crowd control measures should be implemented. Cohorts of health staff that are divided into two sections reduce the risk of cross-infection of staff working in the high risk areas compared to staff working in the low risk area (39). The placement of staff in high-risk buildings should be assessed based on age, presence of comorbidity, social and familial circumstances (for instance if they are a single parent, etc.) (41). These personal

circumstances may indicate that they should not be posted in high-risk buildings as strict infection control measures are imperative (42). Other engineering measures include social distancing, providing good ventilation in OPDs, and creating sheet barriers between doctors and patients (43). Periodic disinfection of the hospital is another engineering measure that requires consideration.

CONCLUSION

Vertical Expansion of the healthcare system demands high funds and resources, whereas the horizontal integration and restructuring of the system seems to be the most appropriate, cost-effective, and sustainable approach. A multifaceted approach to redesigning the health system coupled with the integration of digital health will enable us to combat the current COVID-19 pandemic.

AUTHOR CONTRIBUTIONS

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Impact of Relaxing Covid-19 Social Distancing Measures on Rural North Wales: A Simulation Analysis

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Background: Social distancing policies aimed to limit Covid-19 across the UK were gradually relaxed between May and August 2020, as peak incidences passed. Population density is an important driver of national incidence rates; however peak incidences in rural regions may lag national figures by several weeks. We aimed to forecast the timing of peak Covid-19 mortality rate in rural North Wales.

Methods: Covid-19 related mortality data up to 7/5/2020 were obtained from Public Health Wales and the UK Government. Sigmoidal growth functions were fitted by non-linear least squares and model averaging used to extrapolate mortality to 24/8/2020. The dates of peak mortality incidences for North Wales, Wales and the UK; and the percentage of predicted mortality at 24/8/2020 were calculated.

Results: The peak daily death rates in Wales and the UK were estimated to have occurred on the 14/04/2020 and 15/04/2020, respectively. For North Wales, this occurred on the 07/05/2020, corresponding to the date of analysis. The number of deaths reported in North Wales on 07/05/2020 represents 33% of the number predicted to occur by 24/08/2020, compared with 74 and 62% for Wales and the UK, respectively.

Conclusion: Policies governing the movement of people in the gradual release from lockdown are likely to impact significantly on areas–principally rural in nature–where cases of Covid-19, deaths and immunity are likely to be much lower than in populated areas. This is particularly difficult to manage across jurisdictions, such as between England and Wales, and in popular holiday destinations.

Keywords: Covid-19, rural health, health policy, public health, infectious disease

INTRODUCTION

The Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2) has resulted in 20.7 m cases of Covid-19 worldwide (as of 14th August 2020) (1). Declared a pandemic by the World Health Organization on February the 11th 2020, measures to contain the spread of SARS-CoV-2 has seen most countries impose social distancing measures including restrictions on travel, work and closure of non-essential services. On the 23rd of March a lockdown was introduced in the United Kingdom (UK) to limit further spread of the virus.

Lockdown measures were aimed to suppress viral transmission, maintain a functioning health service, and reduce mortality. The UK Prime Minister, Boris Johnson, announced some easing of the lockdown measures for England on the 10th May 2020. With devolved powers to enforce measures to control movement of people in response to Covid-19, the governments of Wales and Scotland retained their social distancing measures until 1st June 2020. Differences in policies between countries within the UK reflect geographical differences in disease incidence, prevalence and the reproduction number, R_t, which was estimated on the 10th May 2020 to be between 0.5 and 0.9 across the UK, but nearer to 1 in Scotland, and 0.8 in Wales (2).

During the initial phase of the first wave of Covid-19 cases across the UK (March to June 2020), social distancing policies applied at national levels, and did not reflect local variations in detected cases. Within Wales, for instance, the incidence of Covid-19 on 10th May 2020 varied substantially, with 446 cases per 100,000 in the South East (more populated, urban areas) to 247 cases per 100,000 in the North (sparsely populated and more rural) (3). Policies driven largely by changes in transmission rates in populated areas (which had mainly peaked by early May), might not have been applicable to rural areas (where cases had not yet peaked). Consequently, transmission caused by movements of people within and between UK countries may have been mitigated had local contexts been considered sooner. The introduction of local measures did not occur until 29th June 2020, in response to a spike in the number of cases in Leicester, England.

As a case in point, North Wales is primarily a rural region, with the north-west, in particular, being sparsely populated ($<$50 people /km^2), and reliant on the tourism and agricultural economies. North Wales is a popular holiday destination, especially to visitors from the neighboring Liverpool-Manchester megalopolis (population 5.6 million). Over 3.9 million people visited the Snowdonia National Park alone in 2015 (4); and there are more than 5,000 s homes in north-west Wales, where 1 in 3 properties are sold to residents from outside the region. North Wales is served by a unitary health authority (Betsi Cadwaladr University Health Board, BCUHB), providing primary, secondary, community, and social care to 696,300 inhabitants. Increases in the population numbers risk placing pressure on the 3 district general hospitals that have 31 intensive care beds. In response to Covid-19, however, an additional 930 bed spaces have been made available via regional temporary hospitals.

During the weekend prior to the lockdown (21st−22nd March 2020) record numbers of tourists were reported to visit Snowdonia. The Snowdonia National Park Authority described an "unprecedented scene" which saw hundreds of people walking up Wales' highest mountain in what the authority said was "the busiest visitor day in living memory" (5). During this period there was also a surge in the number of people relocating—mainly from the north-west of England—to their second homes in North Wales. A few days immediately following the easing of the lockdown in England (13th May 2020), there were reports of holiday parks being "flooded"

with booking requests, despite more strict laws applying in Wales (6).

The aim of the present analysis was to assess whether the trajectory of Covid-19 related mortality rates reported in BCUHB up to the date of easing of the lockdown in England mirror those for Wales, and UK as a whole. A comparison of forecasted and observed mortality to the end of the first wave (24th August 2020) provided a basis to assess differences in the rate of increase of deaths, timing of peak rates, and decline that may indicate whether earlier implementation of local policies would have been appropriate.

METHODS

Data

Mortality figures for people with a positive test for Covid-19 were obtained from Public Health Wales (3) and the UK Government (7). Both datasets include patients who may have died from other causes, and exclude the deaths of people who were not tested, or who might have died from (or with) Covid-19 but did not tested positive.

Data for the UK and Wales were obtained from the 08/03/2020 and 18/03/2020, respectively, to the 07/05/2020. Data for BCUHB were obtained between the 20/03/2020 and the 07/05/2020; however, daily data for BHUHB were missing between 21/03/2020 to the 23/04/2020 because of a data reporting error and the Health Board reported all of the deaths between these dates on the 24/04/2020. Prior to 21/03/2020, there were fewer than 5 cases of deaths, this being the threshold for disclosing information to avoid de-anonymization.

Analysis

Missing daily data for BCUHB were imputed using the predictions from an exponential function fitted to observed data points. This expression, $Deaths\left(t_{imp}\right) = 1.7233 * exp^{0.0819 * t}$ was assumed to be applicable for historic data during the exponential growth phase of transmission. Cumulative mortality to 7th May 2020 was modeled using a range of sigmoidal growth functions: logistic, S-Shape, Richards, Weibull, and Gompertz functions, which are defined below:

$$Logistic\ Deaths\left(t_L\right) = \frac{a}{1 + b * exp^{-c * t}} \quad (1)$$

$$S - Shape\ Deaths\left(t_S\right) = exp^{a + \left(\frac{b}{t}\right)} \quad (2)$$

$$Weibull\ Deaths\left(t_W\right) = a - b * exp^{-c * t^d} \quad (3)$$

$$Gompertz\ Deaths\left(t_G\right) = a * exp^{-exp^{b - c * t}} \quad (4)$$

$$Richards\ Deaths\left(t_R\right) = \frac{a}{\left(1 + exp^{b - c * t}\right)^{\frac{1}{d}}} \quad (5)$$

Each were fitted to the data by least squares using the non-linear regression function (CurveFit) in Stata version 13 (StataCorp, College Station, TX) (8) to estimate parameters a, b, c, d for each equation. Modeling uncertainty was considered using unweighted model averaging.

TABLE 1 | Parameter estimates for each model.

Model	Model parameters				
	a	b	c	d	r^2
BCUHB					
Logistic	268.37 (16.38)	214.94 (8.22)	0.10 (23.46)		1.000
S-curve	7.44 (74.69)	−142.46 (−25.55)			0.999
Weibull	266.22 (6.96)	260.72 (6.66)	0.00 (1.05)	4.00 (14.12)	0.999
Gompertz	779.23 (3.63)	2.12 (38.98)	0.03 (7.58)		0.999
Richards	261.51 (4.44)	5.67 (2.20)	0.10 (2.48)	1.07 (1.78)	1.000
Wales					
Logistic	1,091.76 (87.69)	172.05 (9.05)	0.14 (39.03)		0.999
S-Curve	8.28 (281.45)	−75.39 (−53.85)			0.998
Weibull	1,112.74 (93.47)	1,141.45 (71.94)	0.00 (3.97)	3.18 (45.04)	0.999
Gompertz	1,252.46 (166.53)	2.56 (122.42)	0.07 (95.01)		1.000
Richards	1,252.33 (166.62)	−5.20 (n/a)	0.07 (95.08)	0.00 (47.81)	1.000
UK					
Logistic	30,984.59 (77.54)	229.88 (8.55)	0.14 (38.32)		0.998
S-curve	11.78 (425.55)	−86.02 (−63.81)			0.998
Weibull	164.84 (3.77)	−53,188 (−48.48)	1,130.74 (8.54)	−1.85 (−51.00)	1.000
Gompertz	36,523 (132.65)	2.65 (112.48)	0.07 (84.31)		1.000
Richards	36,521 (132.66)	−5.85 (n/a)	0.07 (84.33)	0.00 (42.46)	1.000

Data in parentheses are the standard errors.

The date of peak rate of deaths, corresponding to the steepest incline in the rate of cumulative deaths, was derived from the model averaging forecast. The modeled cumulative number of deaths by 24th August 2020 for each region (BCUHB, Wales, United Kingdom) was recorded, and the number of deaths to 07/05/2020 was expressed as a percentage of these values. Comparisons were made with observations available up to 24th August 2020.

RESULTS

Convergence in the non-linear curve fitting was achieved for all functions. However, the parameter estimates for the Richards model indicated equivalence to the Gompertz model. This occurs under certain conditions when parameter d in equation 5 approaches zero, given that the Gompertz model is a special case of Richards model. For this reason, simulations involving the Richards model were not undertaken. The model parameter estimates and associated standard errors are presented in **Table 1**. **Figure 1** depicts the cumulative growth in mortality, with each of the four models superimposed on the observed data used for model fitting. **Figure 2** presents the modeled average nowcast (to 7th May 2020) with reported daily cases of mortality; and forecasted figures with weekly observed data to 24th August 2020.

The peak daily death rate in Wales was modeled to have occurred on the 14/04/2020 (range 11/04/2020–15/04/2020). Peak daily deaths for the UK occurred on 15/04/2020 (range 12/04/2020–20/04/2020)—both indicating that the first peaks for daily deaths had passed by the easing of the lockdowns in each country. For BCUHB, the peak for daily deaths

was modeled to have occurred on the 07/05/2020 (range 02/05/2020–26/05/2020), corresponding to the date for which data were available at the time of analysis. This meant that the date of peak daily deaths for BCUHB was highly uncertain at the time decisions were made to relax the lockdown restrictions.

As of 07/05/2020, the number of deaths reported for BCUHB (167) represented 33% (range 23–63%) of the total forecasted cumulative number for 24th August 2020, suggesting that the region was not yet halfway in terms of absolute numbers of deaths in Covid-19 positive patients. By contrast, deaths across Wales was predicted to be 74% (range 44–100%) of the total, and the UK 62% (range 38–98%).

Based on data up to 7th May 2020, the total forecasted number deaths for the UK, Wales, and BCUHB by 24th August 2020 were, respectively, 49,107 (range 30,985–79,009), 1,497 (1,092–2,530), and 499 (266–736). The recorded numbers of deaths by this date were 41,443, 1,594, and 418, respectively.

DISCUSSION

The analysis demonstrated that parsimonious models of sigmoidal growth provided good fits to observed data up to 7th May 2020 on Covid-19 mortality across the UK, Wales, and North Wales. Averaging these models addressed key modeling uncertainties; and allowed forecasting that provided a reasonable measure of the scale of the first wave of the Covid-19 outbreak up to the 24th August 2020.

Modeling of data up to the 7th May 2020 suggested that the rate of Covid-19 positive deaths in Wales and the UK had already peaked, although there was predicted significant mortality in the weeks and months that followed over the course of the first wave, consistent with multiple other forecast models of Covid-19 (9). The situation was found to be different in North Wales, however, where there remained significant uncertainty concerning the timing of peak mortality. During this time (May 2020), concerns that the incidence of new cases may be rising at a higher rate than the remainder of Wales, coupled with the ≥2 week lag in mortality, implied that reducing strict controls on population movement may have been detrimental to the region's population health.

The fragility of rural North Wales in dealing with Covid-19 in the context of substantial increases in holidaymakers and second home residents is significant. The May 10th announcement of the relaxation in the lockdown for England, included freedom for exercise and outdoor activity, "irrespective of distance." While Wales was still in lockdown during this period, the Welsh Government ruled that stopping people breaking Welsh coronavirus lockdown laws was not a "real option." As it transpired, a relaxation of the lockdown in Wales followed a few weeks later (1st June 2020), but even by then, the peak in mortality had only just passed in North Wales.

FIGURE 1 | Observed (to 7th May 2020) and modeled cumulative mortality in Covid-19 positive patients in the UK **(top)**, Wales **(middle)**, and BCUHB **(bottom)**.
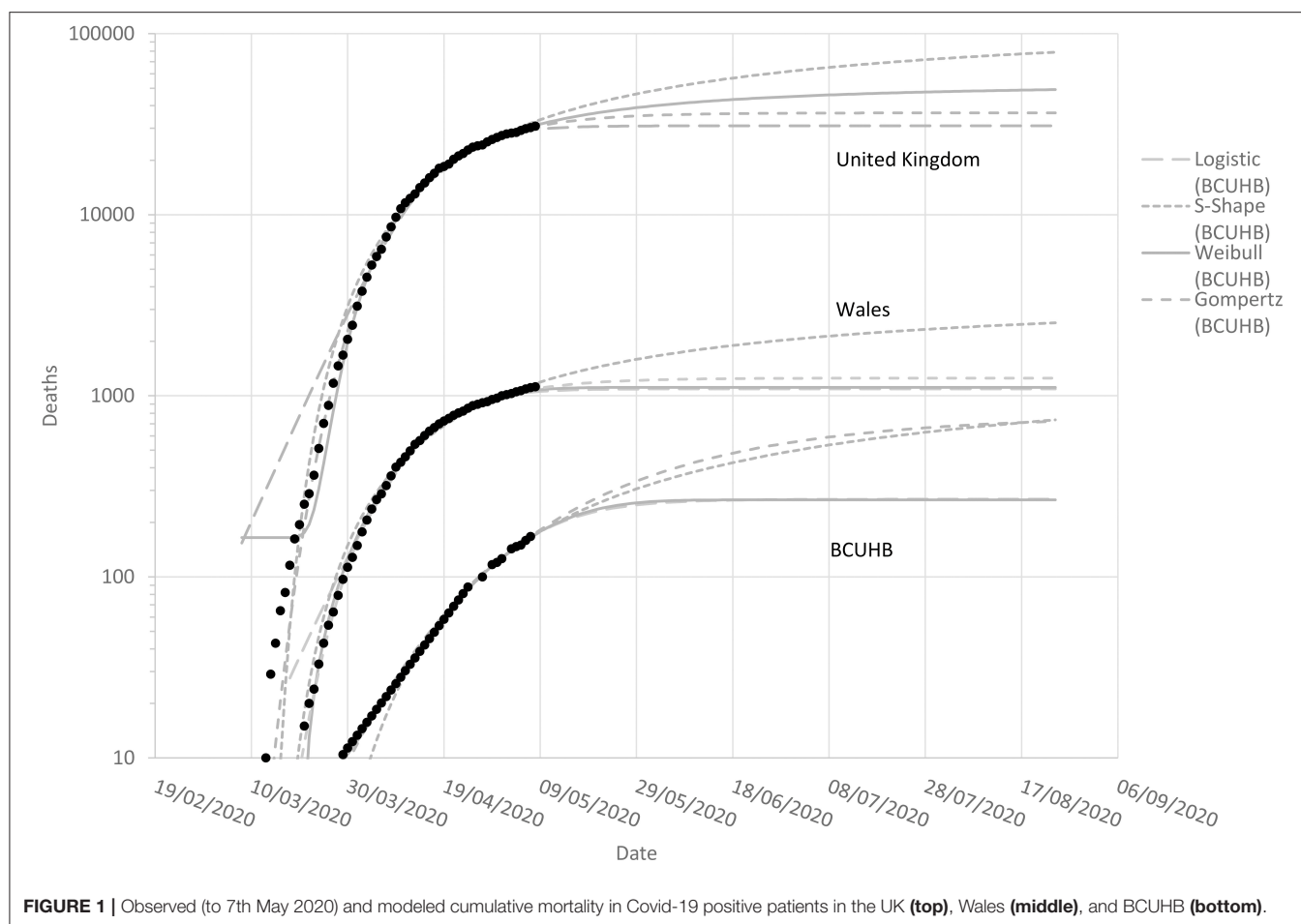
Other factors might also contribute to differential rates of transmission and mortality. An important consideration is population demographics. Between 1997 and 2017, the proportion of the population aged 65 and over in North Wales increased from 19 to 23%, which is significantly higher than the UK average of 18% in 2018. This will have no doubt contributed to increased—if not delayed—death rates in North Wales.

Our analysis has strengths in consideration of multiple sigmoidal growth functions, contrasting with many others, including the influential Institute for Health Metrics and Evaluation (IHME) modeling which relies on a single model, namely the ERF error function. Their approach has been criticized as predictions are extremely labile since new data are included on a daily basis (10). Neither our model nor the IHME model is a disease transmission model, and this represents a limitation. Although in predicting mortality (as opposed to cases), SEIR compartmental models (representing susceptible, exposed, infectious, recovered) may be less reliable. The Covid-19 mortality forecasts made by the US Centers for Disease Control and Prevention are based on an "ensemble" forecast which combines independently developed forecasts into

one aggregate forecast to improve prediction (11). This is equivalent to our model averaging approach, although it may be preferable to weight models based on historical performance (12). Model averaging benefits from possible reduction of predictive error. However, the confidence bounds for averaged models are not readily calculable, hence our presentation of the range of outputs from each individual model as a conservative estimate. A further limitation relates to the data, as not all Covid-19 deaths are reported in NHS and Government figures. Estimations of excess mortality are a more robust estimate of the overall impact of Covid-19, as these are inclusive also of wider impacts of hospital pressures and cancellation of elective procedures.

In conclusion, there were differences in the rates of Covid-19 related mortality across regions of the UK during the first wave in 2020. This may indicate that local measures could be more suited to target spikes in disease incidence. It also suggests that policies governing the movement of people following periods of lockdown might impact differentially depending on such factors as population density and demographics.
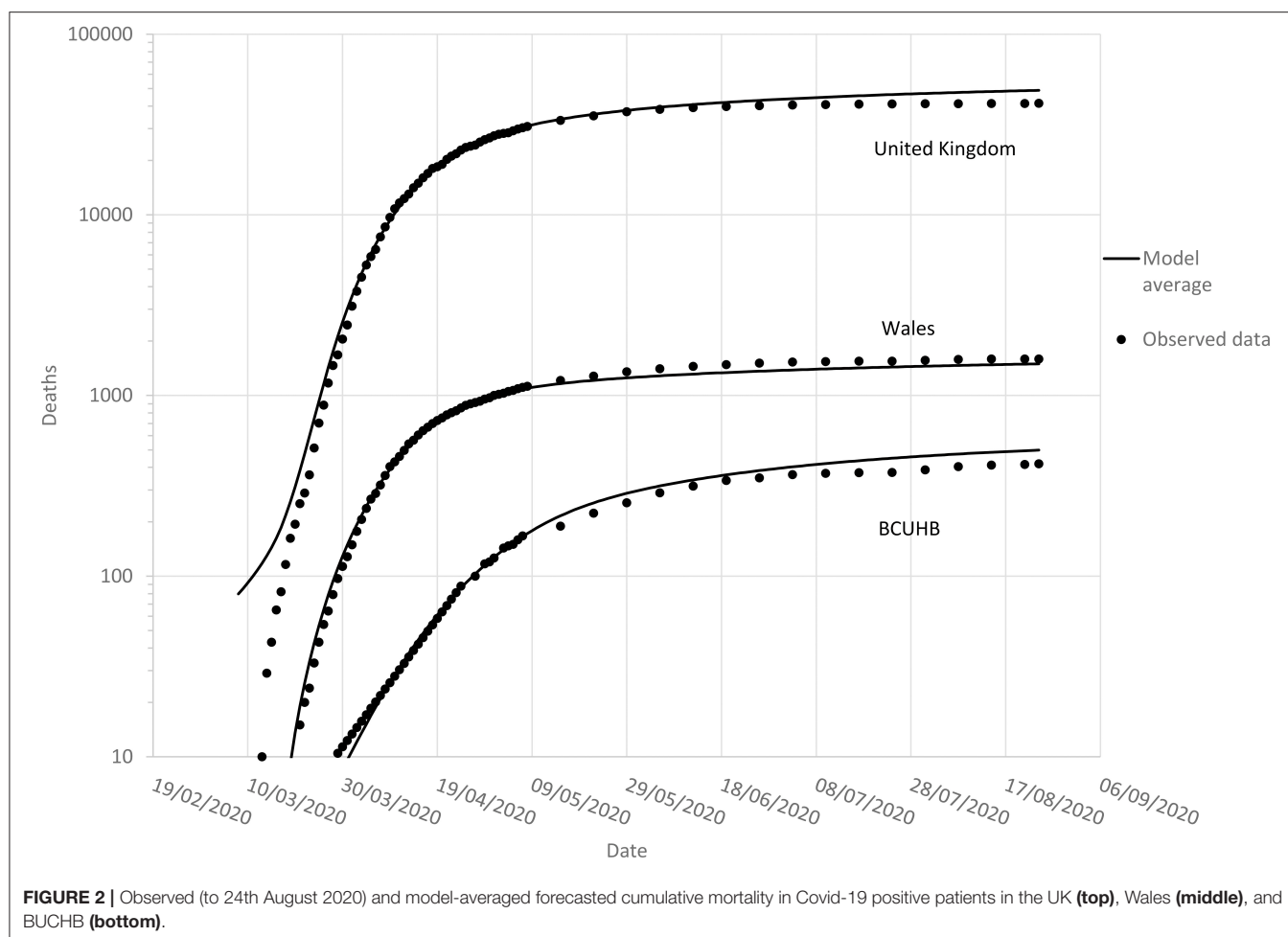
FIGURE 2 | Observed (to 24th August 2020) and model-averaged forecasted cumulative mortality in Covid-19 positive patients in the UK **(top)**, Wales **(middle)**, and BUCHB **(bottom)**.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/supplementary materials, further inquiries can be directed to the corresponding author/s.

ETHICS STATEMENT

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent from the participants' legal guardian/next of kin was not required

to participate in this study in accordance with the national legislation and the institutional requirements.

AUTHOR CONTRIBUTIONS

RH and DH made substantial contributions to the conception and design, acquisition of data, and analysis and interpretation of data. RH drafted the article and gave final approval of the version to be published. DH revised the article critically for important intellectual content and gave final approval of the version to be published.

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Knowledge, Attitude, and Self-Reported Practice Toward Measures for Prevention of the Spread of COVID-19 Among Ugandans: A Nationwide Online Cross-Sectional Survey

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Background: The world is facing the Coronavirus pandemic, which is highly infectious. Several measures have been put in place to prevent its spread among the population. However, for these preventive measures to be effective, the population requires appropriate and sufficient knowledge, attitude, and practices. Thus, a survey to assess knowledge, attitude, and self-reported practice toward measures for prevention of the spread of COVID-19 was conducted among Ugandans.

Methods: This was a cross-sectional study conducted among during the lockdown in Uganda. An online structured questionnaire was used, applying a snowballing sampling approach for recruitment of participants 18 years and above and residing in Uganda. Data collection was done from 6th to 15th April 2020, during which 1,763 people participated. We analyzed all data using STATA 14.2, applying appropriate statistical tests.

Results: Out of 1,763 participants, 80% were highly knowledgeable. For attitude, 72.4% reported following recommendations given by the Ministry of health to prevent the spread of COVID-19; 89.0% were worried about contracting COVID-19 and 73.3% agreed that COVID-19 can be cured and 99.3% reported good practice toward measures to prevent the spread of COVID-19. According to ordered logistic regression, health workers were 6 times more knowledgeable [aOR:6 (3.51–10.09), $p < 0.001$] followed by teachers [aOR:5.2 (2.6–10.32), $p < 0.001$]; students [aOR:3.2 (1.96–5.33), $p < 0.001$]. On the contrary, the drivers, business entrepreneurs, and security personnel had less knowledge.

Conclusion: The results show that the participating Ugandans were knowledgeable and had a positive attitude and good practices. However, there is still a gap in knowledge

among drivers, business entrepreneurs, and security personnel. Therefore, there is a need to mobilize the country's population to have the same degree of knowledge, which will have an impact on the attitude and practices toward prevention of the spread of COVID-19.

INTRODUCTION

On December 31, 2019, a respiratory syndrome identified to be caused by a beta-coronavirus was reported in Wuhan, China (1). This syndrome was later officially named as an outbreak of a new coronavirus disease-2019 (COVID-19) by the World Health Organization (WHO) (2), and as severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) by Coronavirus Study Group (CSG) of the Inter- national Committee on Taxonomy of Viruses, on February 11, 2020 (3, 4).

On March 11, 2020, the WHO declared the COVID-19 as a pandemic due to rapid global spread (5). SARS-CoV-2 presents clinically with fever, dry cough, fatigue, myalgia, and dyspnea (5, 6). The SARS-CoV-2 is transmitted between people through droplets, fomites, and close contact, with possible spread through the eyes, nose, and mouth, but it is not an airborne disease according to the current studies (7). The disease is highly contagious with enormous potential for health, economic, and societal impacts (6).

COVID-19 is rapidly evolving, and currently, there is neither vaccine nor evidence on the effectiveness of potential therapeutic agents (3). As of November 10, 2020, a total of 50,994,215 cases of COVID-19 had been confirmed worldwide (1,892,140 confirmed in Africa), with 1,264,077 deaths (45,605 deaths registered in Africa) giving a case fatality ratio of 3.3% worldwide (2.4% in Africa) (7, 8).

Given the spread of SARS-CoV-2 and its impact on human health, the WHO has recommended strategies to control this pandemic, which include traffic restriction, cancellation of social gatherings, home quarantine, the establishment of clinical care and management strategies, laboratory capacity strengthening, surveillance strategies, case and contact tracing, infection prevention and control, implementation of health measures for travelers, risk communications, and community engagement (8, 9).

Uganda registered her first case of COVID-19 on March 21, 2020, and as of November 10, 2020, according to the Ministry of Health (MOH), the country had registered 14,704 confirmed cases of COVID-19 with 7,836 recoveries and with 133 reported deaths, a case fatality ratio of 0.9% (10). The Uganda government has put measures to contain the spread of the SARS-CoV-2 within the country, including community-based and facility-based measures (10). The key community-based measures include self-isolation for COVID-19 patients and quarantine of contacts and travelers, hand-washing with soap or sanitizers, restriction of movements (lockdown) within and out of the country except for cargo drivers, all gathering places closed such as school, churches, sports, meetings, markets except for food necessities activities and a curfew from 7 pm to 6:30 am, face

mask for everyone in the country (10). Facility-based measures have so far included the use of personal protective equipment before handling patients, testing of patients with symptoms, treatment, and contact tracing, and the isolation of the suspected cases and diagnosed cases (10).

Appropriate knowledge, attitudes, and practices could improve the proper uptake of COVID-19 prevention measures. Studies so far done to evaluate the level of KAP toward measures to prevent the spread of COVID-19 among certains African communities and in Uganda in particular have targeted specific groups such as health workers (11), lecturers and students (12) and market vendors (13). These studies show a good knowledge, a positive attitude and good practices among the mentioned participants. However, our study aimed at the general population to determine the variability in knowledge, attitudes, and practices toward measures for prevention of the spread of COVID-19 among different sectors in a bigger Ugandan population. Previous studies on viral disease outbreaks, like SARS in 2003 (14) and Ebola in 2018 (15), have shown that the management and control of an outbreak requires a good understanding by the populations about the disease transmission and prevention to avoid its spread in the community (6).

MATERIALS AND METHODS

Study Design and Setting

This was a nationwide cross-sectional online survey conducted among Ugandans living in any of the four regions (Northern, Central, Eastern, and Western) of the country at the time of the study.

Study Population, Sample Size and Sampling Design

All literate Ugandans aged 18 years and above with access to the internet constituted the population of this survey. The population of Uganda stands at 44,269,594, of which 78.4% (34,707,362/44,269,594) are literate (16). In Uganda, 44% (20,000,000/44,269,594) of the general population have a mobile subscription, among whom nearly half are mobile subscribers who are also able to access mobile internet services (17). By June 2018, there were nearly 10 million mobile internet connections in Uganda, a penetration rate of 23% (17).

To calculate the sample size for this study, we hypothesized that at a 99.9% confidence interval (CI), 50% of the respondents would have a satisfactory knowledge level on measures to prevent the spread of COVID-19 in the country. Using the Open Source Epidemiologic Statistics for Public Health (OpenEpi), v.3.01 (Dean AG, Sullivan KM, Soe MM. OpenEpi: www.OpenEpi.com, updated April 6, 2013), the minimum sample size of 1,083 participants was needed, adding a 30% contingency to the sample

size, a minimum of 1,408 participants were targeted and at the end of data collection period, a total of 1,768 participants were registered in the study.

Ugandans with a minimal computer literacy level and able to operate a social media account such as an email, WhatsApp, Twitter, or Facebook and consented to participate were included in the survey. Those who had filled in the form but were unable to submit the questionnaire were automatically not reflected and therefore excluded in the survey's database.

Data Collection and Instrument

Due to the spread of the COVID-19 pandemic and the lockdown policy enforced in the country at the time of data collection, a physical and paper-based questionnaire was not feasible. Data was collected using an online structured questionnaire developed in English using Google forms[1] with a consent form appended to it.

The questionnaire was developed based on WHO requirements for knowledge, attitudes, and practices (KAP) (18) and from the validated and published study on KAP among Chinese (6) and it was composed of 22 questions focused on several key constructs. The constructs captured by the five questions on socio-demographic characteristics (age, sex, occupation, location, and marital status); eight on knowledge; three on attitude, one on self-reported practice toward the measures put in place to prevent the spread of COVID-19 among Ugandans and one on source of information. The knowledge questions were composed of 12 questions (K1–K12) comprising: (K1) incubation; (K2) mode of transmission of the COVID-19; (K3) clinical presentations of COVID-19; (K4) risk factors for severe illness of COVID-19 and (K5–K12) preventive measures. Three (A1–A3) attitudes questions assessed participant's responses related to their COVID-19 risk perceptions, measures to prevent the spread of the disease and their level of perception about the cure of COVID-19. One (P1) question assessed participants response related to the measures they observed for self-prevention toward COVID-19. Participants were asked their source of information about COVID-19 (**Supplementary Table 1**).

As the country was under lockdown limiting physical access to potential study participants, social media was used to conduct the survey. The snowball sampling technique was used by asking all initial study participants accessing the online form to recruit their acquaintances fulfilling the eligibility criteria, by sharing the link to the online questionnaire and requesting them to participate within the study timeline. The questionnaire was administered for a period of 10 days from 6th to 15th April 2020. On receiving and clicking the link, the participants were auto-directed to the informed consent page of the survey tool. After reading the preamble and accepting to participate in the study, they were directed to the survey questionnaire.

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[1]https://docs.google.com/forms/d/18Ded-NFe65B6HnTFCwe4XzxBA-o3VfcJYogRjgcMsAA/edit

Data Analysis and Interpretation

Each rightly mentioned single and multiple choices responses on knowledge questions was scored 1 to give a total score for the knowledge of a particular participant. The range of the knowledge was scored 0–30. The knowledge score was grouped into 3 categories namely: 0–9 (poor), 10–19 (moderate), and 20–30 (high).

Those who "Agreed" or answered "Yes" to the questions related to attitude were scored 1 and those who "Disagreed" or said "No" were coded 0. The category of attitude for this study was a binary variable with score 1 taken to be positive attitude and score 0 as negative attitude.

Each correct response on self-reported practice questions was scored 1 and the incorrect one was scored 0 and then the sum of all the 8 right responses was used to develop a practice score. The self-reported practice was scored as adequate or good practice for those who selected 5–8 correct answers and poor for others who selected 0–4 correct answers.

The raw data was cleaned and entered into Microsoft Excel and exported into STATA 14.2 for processing. Statistical analysis was done using STATA 14.2, where by categorical variables were summarized using frequency tables while continuous variables were summarized using means and standard deviation (SD).

The distances between the categories of the knowledge score were not normally distributed, and therefore, we used the ordered logistic regression for multivariable analysis of knowledge and socio-demographic characteristics indicating adjusted odds ratios (aOR).

The attitude and Self-reported practice and socio-demographic characteristics were analyzed using the Chi-square, p-values at univariate analysis, and Odds ratio at 95% CIs. The statistical significance level was set at $p < 0.05$.

Ethical Considerations

Ethical clearance for the survey was obtained from the Institutional Research Ethical Committee of Kampala International University in Uganda (UG-REC-023/201914). As participants logged in online, a statement regarding the consent to participate in the survey was in the preamble of the questionnaire and could only proceed after reading the consent and accepting to participate in the survey. Participation in this survey was voluntary. Participants were free to withdraw from the survey at any time by not submitting their form online, and there was no repercussion. The participants' identity was concealed as the form does not require any identification. No name or mail was required from the participant. Therefore, the information was obtained and stored anonymously, and this was treated confidentially. Only five members of the research team were allowed to access data, and the principal investigator accessed the entire dataset.

RESULTS

A total of 1,768 participants completed the online questionnaire. Five (5) participants were excluded from the survey because were aged below 18 years, thus the final sample size considered was 1,763.

TABLE 1 | Socio-demographic characteristics of participants.

Variable	Options	Frequency	Percent (%)	Mean age (SD)
Number of participants		1,763	100	
Age in complete years				**32.1 (9.9)**
Age group in years	18 to 30	892	50.6	
	31 to 40	549	31.1	
	41 to 50	231	13.1	
	51 and above	91	5.2	
Sex	Female	759	43.1	
	Male	1,004	56.9	
Marital status	Single	891	50.5	
	Married	811	46.0	
	Divorced	42	2.4	
	Other*	19	1.1	
Occupation	Farmers	247	14	
	Business	284	16.1	
	Health workers	418	23.7	
	Household	67	3.8	
	Security	49	2.8	
	Student	346	19.6	
	Teacher	119	6.7	
	Driver	50	2.8	
	Others**	183	10.4	
Location (region)	Western	756	42.9	
	Central	517	29.3	
	Eastern	263	14.9	
	Northern	227	12.9	

Other: Widowed, cohabiting, separated and in relation.*
*Other**: Technologist and point of entry agent.*

TABLE 2 | Ordered logistic regression of knowledge level with socio-demographic characteristics of participants.

Variable	Coefficient (95%CI)	aOR (95%CI)	*p*-Value
Sample size		1,763	
Age group in years			**0.364**
18 to 29	Ref	Ref	
30 to 40	0.2 (−0.2–0.53)	1.2 (0.82–1.7)	0.371
41 to 50	0.1 (−0.38–0.57)	1.1 (0.68–1.76)	0.699
51 and above	−0.3 (−0.92–0.28)	0.7 (0.4–1.32)	0.296
Sex			**0.055**
Female	Ref	Ref	
Male	0.3 (−0.01–0.56)	1.3 (0.99–1.75)	0.055
Marital status			**0.361**
Single	Ref	Ref	
Married	0.1 (−0.25–0.47)	1.1 (0.78–1.6)	0.542
Divorced	−0.5 (−1.35–0.3)	0.6 (0.26–1.35)	0.213
Others*	−0.5 (−1.81–0.89)	0.6 (0.16–2.43)	0.502
Occupation			**0.001**
Farmers	Ref	Ref	
Business	0.3 (−0.1–0.7)	1.3 (0.9–2.01)	0.145
Health workers	1.8 (1.26–2.31)	6 (3.51–10.09)	0.001
Household	0.3 (−0.3–0.98)	1.4 (0.74–2.67)	0.295
Security	0.7 (−0.1–1.44)	2 (0.91–4.21)	0.087
Student	1.2 (0.67–1.67)	3.2 (1.96–5.33)	0.001
Teacher	1.6 (0.96–2.33)	5.2 (2.6–10.32)	0.001
Driver	−0.4 (−1.12–0.22)	0.6 (0.33–1.25)	0.192
Others**	1.9 (1.2–2.6)	6.7 (3.32–13.4)	0.001
Location (region)			**0.001**
Western	Ref	Ref	
Central	0.4 (0.03–0.73)	1.5 (1.03–2.08)	0.034
Eastern	1.1 (0.61–1.5)	2.9 (1.84–4.48)	0.001
Northern	0.6 (0.12–1.05)	1.8 (1.12–2.85)	0.014

aOR, adjusted odds ratio; Ref, reference variable group.
Other: Widowed, cohabiting, separated and in relation.*
*Other**: Technologist and point of entry agent.*

Socio-Demographic Characteristics of Participants

Out of 1,763 participants, 56.9% were male and 50.5% were single. The mean age of the overall respondents was of 32.1($\pm$ 9.9) years. 23.7% (418/1,763) were health workers, 14% (247/1,763) farmers and 2.8% (50/1,763) drivers. The majority, 42.9% (756/1,763), of participants were from Western region of Uganda, followed by Central Uganda (29.3%). Other socio-demographic characteristics are shown below in **Table 1**.

Ordered Logistic Regression of Knowledge Level With Socio-Demographic Characteristics of Participants

The knowledge scores significantly differed across occupation and location ($p < 0.05$) of the study participants but was not significant across age groups, sex and marital status ($p > 0.05$) in ordered logistic regression analysis (**Table 2**). However, knowledge scores significantly differed across the

socio-demographics variables ($p < 0.05$) in the univariate analysis (**Supplementary Table 2**). The source of information about COVID-19 among participants were as follow: social media 36.8% (648/1,763), television 29.9% (528/1,763), health workers 12.9% (227/1,763), radio 12% (212/1,763), Family and friends 5.2% (91/1,763) and News Papers 3.2% (57/1,763).

Eighty percent (1,411/1,763) of the study participants had high knowledge about COVID-19, 18.3% (323/1,763) moderate knowledge and 1.7% (29/1,763) poor knowledge (**Supplementary Table 2**).

The ordered logistic regression of knowledge level (**Table 2**) shows that health workers [aOR:6 (3.51–10.09), $p < 0.001$]; teachers [OR:5.2 (2.6–10.32), $p < 0.001$]; students [aOR:3.2 (1.96–5.33), $p < 0.001$] were significantly associated with a high level of knowledge toward measures to prevent the spread of COVID-19. On contrary, being a business merchant [OR:1.3 (0.9–2.01), $p : 0.145$]; security agent [aOR: 2 (0.91–4.21), $p : 0.087$], household-wife [aOR: 1.4(0.74–2.67), $p : 0.295$] and driver

[0.6 (0.33–1.25), $p : 0.069$] were not significantly associated with a high knowledge about COVID-19 which is supported by the prevalence of knowledge in **Supplementary Table**. There was no statistically significant difference in knowledge on prevention of the spread of COVID-19 among participants regarding their location.

Attitude Toward Measures to Prevent the Spread of COVID-19 With Socio-Demographic Characteristics of Participants

Most participants [72.4% (1,276/1,763)] followed recommendations that have been given by the MOH or DHO to prevent the spread of COVID-19 but 27.6% (487/1,763) did not follow the recommendations; 89.0% (1,570/1,763) were worried about contracting COVID-19 and 73.3% (1,293/1,763) agreed that COVID-19 can be cured (**Figure 1**). The attitude about contracting COVID-19 (A1) varied across sex, marital status and location ($p < 0.05$). The attitude on following the recommendations (A2) and on agreeing that COVID-19 can be cured (A3) differed across sex and occupation (**Table 3**). The distribution of high knowledge on measures to prevent the spread of COVID-19 among participants was significant for positive attitude on A1 and A3 but not A2 (**Table 3**).

Self-Reported Practice Toward Measures for Prevention of the Spread of COVID-19 With Socio-Demographic Characteristics of Participants

Participants reported good practice of 99.26% for self-monitoring, use of face masks, washing hands, application of social distancing respectively; 85.25% for house cleaning and ventilation; 68.29% of staying at home and avoiding gathering; 30.97% of applying respiratory etiquette. But some of participants reported applying social distancing of <1 m (14.01%) and some (0.7%) did not follow any of the mentioned measures to prevent the spread of COVID-19 in Uganda (**Table 4**). The practices differed significantly across sex, marital status and occupation of participants ($p < 0.05$). Most participants (99.3%) reported having adequate practice and 0.7% (13/1,763) reported poor practice toward measures for prevention of the spread of COVID-19 (**Table 5**).

DISCUSSION

Currently, the world faces the coronavirus pandemic, which is highly infectious; measures have been put in place to prevent its spread among the population across the world. The population requires an appropriate and sufficient knowledge about these
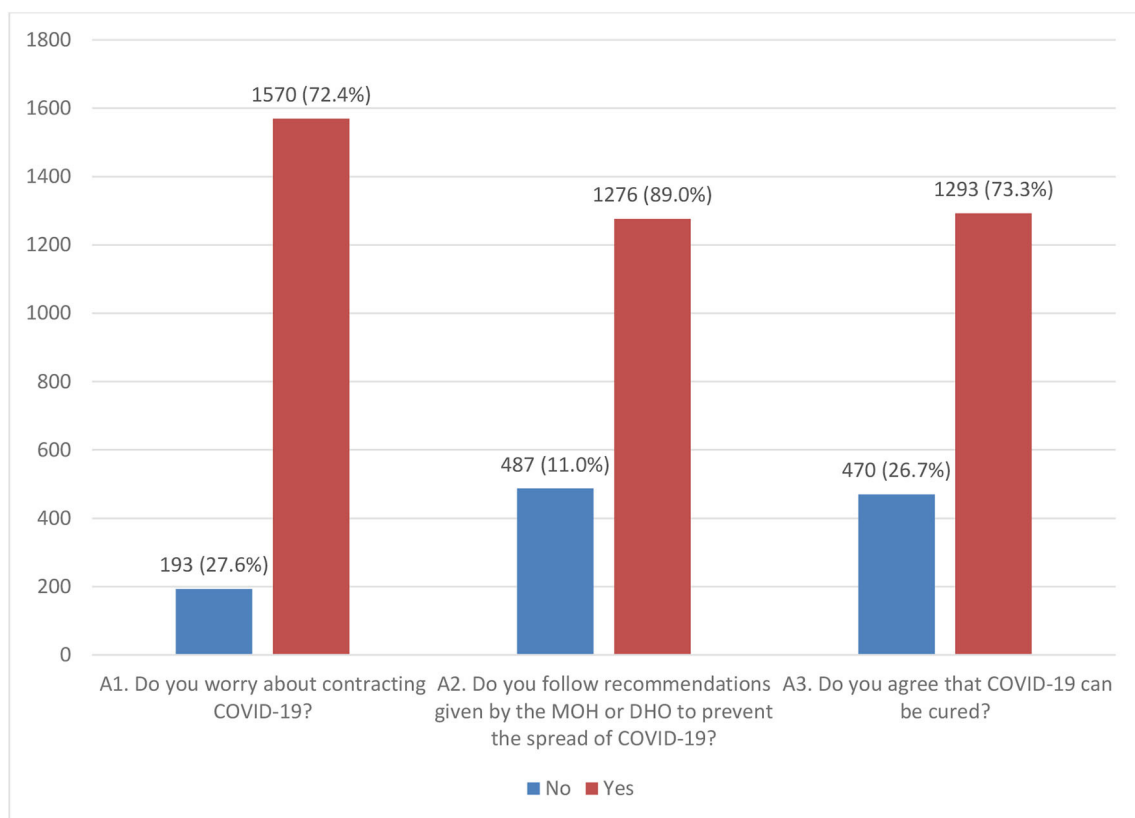
FIGURE 1 | Attitude toward measures to prevent the spread of COVID-19 among Ugandans. MOH, Ministry of Health; DHO, district health officer.

TABLE 3 | Association of attitude with socio-demographic characteristics of participants.

Variable	All (%)	A1. Do you worry about contracting COVID-19?			A2. Do you follow recommendations given by the MOH or DHO to prevent the spread of COVID-19?			A3. Do you agree that COVID-19 can be cured?		
		Positive (%)	Negative (%)	p	Positive (%)	Negative (%)	p	Positive (%)	Negative (%)	p
Sample size	1,763 (100)	1,570 (89.1)	193 (10.9)		1,276 (72.4)	487 (27.6)		1,293 (73.3)	470 (26.7)	
Age group in years				0.102			0.703			0.832
18–29	892 (100)	779 (87.3)	113 (12.7)		650 (72.9)	242 (27.1)		658 (73.8)	234 (26.2)	
30–40	549 (100)	495 (90.2)	54 (9.8)		398 (72.5)	151 (27.5)		403 (73.4)	146 (26.6)	
41–50	231 (100)	213 (92.2)	18 (7.8)		167 (72.3)	64 (27.7)		169 (73.2)	62 (26.8)	
51 and above	91 (100)	83 (91.2)	8 (8.8)		61 (67)	30 (33)		63 (69.2)	28 (30.8)	
Sex				0.032			0.009			0.015
Female	759 (100)	662 (87.2)	97 (12.8)		525 (69.2)	234 (30.8)		579 (76.3)	180 (23.7)	
Male	1,004 (100)	908 (90.4)	96 (9.6)		751 (74.8)	253 (25.2)		714 (71.1)	290 (28.9)	
Marital status				0.001			0.219			0.318
Single	891 (100)	778 (87.3)	113 (12.7)		639 (71.7)	252 (28.3)		660 (74.1)	231 (25.9)	
Married	811 (100)	743 (91.6)	68 (8.4)		598 (73.7)	213 (26.3)		594 (73.2)	217 (26.8)	
Divorced	42 (100)	31 (73.8)	11 (26.2)		25 (59.5)	17 (40.5)		28 (66.7)	14 (33.3)	
Others*	19 (100)	18 (94.7)	1 (5.3)		14 (73.7)	5 (26.3)		11 (57.9)	8 (42.1)	
Occupation				0.051			0.001			0.001
Farmers	247 (100)	213 (86.2)	34 (13.8)		125 (50.6)	122 (49.4)		196 (79.4)	51 (20.6)	
Business	284 (100)	262 (92.3)	22 (7.7)		201 (70.8)	83 (29.2)		225 (79.2)	59 (20.8)	
Health workers	418 (100)	385 (92.1)	33 (7.9)		342 (81.8)	76 (18.2)		293 (70.1)	125 (29.9)	
Household	67 (100)	58 (86.6)	9 (13.4)		39 (58.2)	28 (41.8)		52 (77.6)	15 (22.4)	
Security	49 (100)	43 (87.8)	6 (12.2)		36 (73.5)	13 (26.5)		43 (87.8)	6 (12.2)	
Student	346 (100)	295 (85.3)	51 (14.7)		268 (77.5)	78 (22.5)		233 (67.3)	113 (32.7)	
Teacher	119 (100)	104 (87.4)	15 (12.6)		96 (80.7)	23 (19.3)		89 (74.8)	30 (25.2)	
Driver	50 (100)	46 (92)	4 (8)		29 (58)	21 (42)		35 (70)	15 (30)	
Others**	183 (100)	164 (89.6)	19 (10.4)		140 (76.5)	43 (23.5)		127 (69.4)	56 (30.6)	
Location (region)				0.039			0.001			0.386
Western	756 (100)	688 (91)	68 (9)		616 (81.5)	140 (18.5)		552 (73)	204 (27)	
Central	517 (100)	444 (85.9)	73 (14.1)		330 (63.8)	187 (36.2)		386 (74.7)	131 (25.3)	
Eastern	263 (100)	235 (89.4)	28 (10.6)		182 (69.2)	81 (30.8)		198 (75.3)	65 (24.7)	
Northern	227 (100)	203 (89.4)	24 (10.6)		148 (65.2)	79 (34.8)		157 (69.2)	70 (30.8)	
Knowledge				0.001			0.116			0.001
Poorly	29 (100)	5 (17.2)	24 (82.8)		17 (58.6)	12 (41.4)		16 (55.2)	13 (44.8)	
Moderate	323 (100)	167 (51.7)	156 (48.3)		245 (75.9)	78 (24.1)		270 (83.6)	53 (16.4)	
Highly	1,411 (100)	1,104 (78.2)	307 (21.8)		1,031 (73.1)	380 (26.9)		1,284 (91.0)	127 (9.0)	

aOR, adjusted odds ratio; Ref, reference variable group.
Other*: Widowed, cohabiting, separated and in relation.
Other**: Technologist and point of entry agent.

measures, their importance, and how to apply them appropriately (8, 9). When a human population faces an outbreak, changes in behavior in response to the disease can alter the progression of the infectious agent. In particular, people aware of a disease in their proximity can take measures to reduce their susceptibility (18).

However, beyond a critical infection rate, spreading awareness can slow down the spread of the disease and lower the final incidence, but it cannot completely stop it from reaching epidemic proportions and taking over large parts of the population (6) as have been observed in the 2003 outbreak of SARS in Hong Kong (19).

Ten days after the first case of COVID-19 was confirmed in Uganda, we conducted a nationwide online survey on Knowledge, attitudes, and self-reported practice toward measures for prevention of the spread of COVID-19 among the Ugandan population. We found that 80% of participants were highly knowledgeable toward measures for the prevention of the spread of COVID-19 among Ugandans. This result is similar to the knowledge rate (90%) found among Chinese residents during a quick online survey on COVID-19 (6) and during the Ebola outbreaks in Sierra Leone in 2014 (20) and DRC in 2018 [12 = 15] but higher than findings (69%) by Olum et al. (11) among Health

TABLE 4 | Reported practices to prevent the spread of COVID-19 among Ugandans.

	Self-reported practices items (multiple response)	Frequency	Percent
1	Self-monitoring	1,750	99.26
2	Use of masks	1,750	99.26
3	Hand washing	1,750	99.26
4	Social distancing of more than two meters	1,750	99.26
5	House cleaning and ventilation	1,503	85.25
6	Avoid gatherings	1,204	68.29
7	Stay at home	1,204	68.29
8	Respiratory etiquette	546	30.97
9	Social distancing of <1 m	247	14.01
10	I don't know	13	0.74

TABLE 5 | Self-reported practice toward measures for prevention of the spread of COVID-19 with socio-demographic characteristics.

Variable	Total (%)	Good (%)	Poor (%)	*p*-Value
Sample size	1,763 (100)	1,750 (99.3)	13 (0.7)	
Age group in years				
18 to 29	892 (100)	888 (99.6)	4 (0.4)	0.494
30 to 40	549 (100)	544 (99.1)	5 (0.9)	
41 to 50	231 (100)	228 (98.7)	3 (1.3)	
51 and above	91 (100)	90 (98.9)	1 (1.1)	
Sex				
Female	759 (100)	749 (98.7)	10 (1.3)	0.013
Male	1,004 (100)	1,001 (99.7)	3 (0.3)	
Marital status				
Single	891 (100)	886 (99.4)	5 (0.6)	0.002
Married	811 (100)	806 (99.4)	5 (0.6)	
Divorced	42 (100)	40 (95.2)	2 (4.8)	
Others*	19 (100)	18 (94.7)	1 (5.3)	
Occupation				
Farmers	247 (100)	239 (96.8)	8 (3.2)	0.001
Business	284 (100)	283 (99.6)	1 (0.4)	
Health workers	418 (100)	417 (99.8)	1 (0.2)	
Household	67 (100)	66 (98.5)	1 (1.5)	
Security	49 (100)	49 (100)	0 (0)	
Student	346 (100)	346 (100)	0 (0)	
Teacher	119 (100)	119 (100)	0 (0)	
Driver	50 (100)	49 (98)	1 (2)	
Others**	183 (100)	182 (99.5)	1 (0.5)	
Location (region)				
Western	756 (100)	753 (99.6)	3 (0.4)	0.087
Central	517 (100)	509 (98.5)	8 (1.5)	
Eastern	263 (100)	262 (99.6)	1 (0.4)	
Northern	227 (100)	226 (99.6)	1 (0.4)	

Other: Widowed, cohabiting, separated and in relation.*
*Other**: Technologist and point of entry agent.*

Workers in Uganda and by Hager et al. among communities in Nigeria and Egypt (61.6%) (21). Our findings could be explained by the fact that the COVID-19 found Ugandans already familiar with observing similar measures to prevent the spread of some other highly infectious diseases within the country such as Ebola and Marburg disease (22). The ordered logistic regression from our survey showed that the level of knowledge was significantly associated with a certain degree of education level as per health worker, teacher, and student. This survey included all Ugandans with a minimal computer literacy level which is 78.4% of all the Ugandan population (17). The Ministry of Health of Uganda uses social media to post information related to measures for prevention of the spread of the pandemic within the country and this could explain the findings mentioned above which could be different among uneducated people. Zhong et al. findings related to Knowledge in China explain their findings by the fact that most respondents during their survey held an associate's degree or higher (6). The Uganda government could use these categories of participants as a strategy to reach out and sensitize the uneducated population about measures to be observed in the country.

Most participants reported positive attitude on following recommendations that have been provided by the Ministry of Health or directorate of district health officer to prevent the spread of COVID-19. Even if the participants agreed that COVID-19 can be cured (73.3%), most of them were worried of contracting COVID-19 (89.1%). These findings can be explained by the high level of knowledge among participants, and also, the country being under lockdown as one of the measures to prevent the spread of the pandemic. A study conducted about KAP of COVID-19 in the Philippines found that most of participants were afraid of contracting COVID-19 (19). Reuben et al. found an association of good knowledge and positive attitude among participants about COVID-19 (23). In China, a survey revealed that most population took precautions to prevent infection by COVID-19 such as not going to crowded places and wearing masks when going outside but with an optimistic attitude toward COVID-19 which could be attributed to the stringent prevention

and control measures implemented by governments such as banning public gatherings (6). In Nigeria, a study evaluating the KAP of Ebola outbreak among secondary school children found an association between poor knowledge and negative attitude toward the outbreak (20). In this survey, householder and driver occupation were associated with a negative attitude. During the Ebola outbreak in DRC and Guinea, it was found that a group of participants had a negative attitude toward measures for prevention of Ebola in their respective areas (15, 24) the same as for a study done among Chinese residents during the coronavirus pandemic (6). Among confirmed cases in Uganda, one-third are truck drivers who are coming from surrounding countries (10). The result gives useful information that the government has to increase sensitization among these categories of people about measures toward prevention of the spread of COVID-19, which can be considered as a cross border infection in Uganda and the East African region. Households can get information from the students, health workers (11, 12) and those

who have shown an immense knowledge about measures to be observed and the government can also tap into such categories of people in implementing strategies to control the pandemic within the country.

As of November 10, 2020, Uganda had registered 14,704 confirmed cases of COVID-19 with 7,836 recoveries and with 133 reported deaths, a case fatality ratio of 0.9% (10), and this low case fatality ratio can be explained by high prevalence (99.3 %) of good practice among Ugandans.

Similar KAP studies among students, lectures, health workers, and rural market vendors in Uganda suggested that education level could play a key role in molding KAP in the community (11–13).

In our study occupations such as security agents, drivers, and business people had a low level of knowledge on COVID-19. These categories of the population need an urgent sensitization across the country to mitigate the spread of COVID-19. If measures are not considered, Uganda could continue to register increasing numbers of confirmed cases by these categories.

Our study was limited to participants who had smartphones, computers, tablets, and internet connectivity and had an understanding of English. Therefore, those with no smartphones and internet connectivity could not access the online form and participate in the survey. The survey captured the country's literate population, so it could not be generalized to the whole population. The knowledge and attitudes among uneducated people might be different from the findings of this survey.

Therefore, knowledge and attitudes toward COVID-19 of vulnerable populations deserve special research attention. There was an inadequate assessment of attitudes toward COVID-19, which should be developed via focus group discussion and in-depth interviews and constructed as multi-dimensional measures the same as for self-reported practice, which is not easy to evaluate as the survey was online. However, this was not possible due to the country's lockdown during the survey period, and one of the strategies observed by all population in the country was social distancing to avoid the spread of the COVID-19.

CONCLUSION

At the time of the study, most Ugandans were knowledgeable, had a positive attitude, and observed good practices toward measures to prevent the spread of COVID-19 within the country. Despite these findings, there was lack of knowledge and attitude among specific populations, namely drivers, business entrepreneurs, and security personnel. These groups should be targeted for sensitization to avoid becoming the source of spread of the coronavirus disease. There is a dire need to mobilize all populations around the country to have the same level of knowledge, which will impact attitude and practice. The government of Uganda could use the health workers, teachers, and students to help in mobilization of all populations within the country about measures toward prevention of the spread of the coronavirus pandemic.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/**Supplementary Material**, further inquiries can be directed to the corresponding author/s.

ETHICS STATEMENT

Ethical clearance for the survey was obtained from the Institutional Research Ethical Committee of Kampala International University in Uganda (UG-REC-023/201914). As participants logged in online, a statement regarding the consent to participate in the survey was in the preamble of the questionnaire and could only proceed after reading the consent and accepting to participate in the survey. Participation in this survey was voluntary. Participants were free to withdraw from the survey at any time by not submitting their form online, and there was no repercussion.

AUTHOR CONTRIBUTIONS

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpubh.2020.618731/full#supplementary-material

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COVID-19 Unintended Effects on Breast Cancer in Italy After the Great Lockdown

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Italy introduced social distancing measures, which limited the spread of COVID-19; all the non-life-threatening treatments have been temporarily suspended, including screening programs. This decision leads to unintended effects on the ability to detected neoplasia in their first stages. Possible future outcomes of the ability to detect new breast cancer cases based on two alternative scenarios show that the reduction in organized screening activities will limit the ability to detect no <3.43% of the new cases; the economic crisis will reduce voluntary screening, increasing the undetected new cases up to 11.73%. Cases diagnosed with delay will show up in their advanced stage along with unknown effects on mortality and health care costs. Global health care policies should be implemented to counterbalance these adverse effects.

Keywords: breast cancer, screening, COVID-19, patients' sensibilization, Italy, European recovery plan, public health, global policy

INTRODUCTION

On 31 January 2020 the spread of the New Coronavirus SARS2—named COVID-19 has been officially announced by the World Health Organization (1). The pandemic has been declared in March 2020 and the state of emergency will last until January 2021 in Italy. Different epidemiological models provide slightly different projections over the period necessary for the reproduction number (R0) of the COVID-19 virus to fall below (1): this condition confirm that emergency are apparently under control. The Imperial College (2) model estimates that the minimum period necessary to stop the spreading of the COVID-19 is 12–15 weeks (i.e., 3–4 months); presence of COVID-19 virus has been detected in November in China, and in late December first case was reported in North of Italy. China has been the first to lockdown the country in January 2020 to limit the exponential spread of the reproduction number of the virus COVID-19, Italy followed in March 2020, the first country in Europe and among the G-7. During the lockdown period, social distancing measures have been introduced (3, 4). "Global health security is a shared responsibility; it requires a collaborative collective response based on transparency and trust (5)." Sanitary uncertainty due to COVID-19 revealed several systemic weaknesses and has been translated into economic effects that are similar to those of a war; according to available forecasts (6), the COVID-19 pandemic will create a structural break in the public expenditure, namely of health care, social expenditure and unemployment benefits, and ultimately on public debts. Most European countries have explicitly adopted principles of rights and duties to address the COVID-19 health emergency. The Prime ministers of France, Italy, Spain, and Germany in March and April 2020 have all publicly declared that "cost" will not be a consideration in fighting the COVID-19 virus, or in making medical treatment available; the analytical framework adopted

by these governments accepts a fiduciary duty to protect their citizens' health. On the other side, countries as Sweden and Brazil, that adopted the cost-benefit analysis to manage the health emergency; their choice not to lock down the country has been insensitive to both distributive and rights-based considerations (7). The medium to long-term effects of the pandemic depend on various known and unknown factors, and the economic literature provides little help to guide for policymakers. Available forecasts consider:

1. The duration of the lockdown and the (estimated) number of spikes in the curve of infected-sick in 2020–2021.
2. Direct effects on consumption, investment, unemployment, mortality, and public health care expenditure rates.
3. Side effects (including psychological) on the economy and population; some (but not all) are the growing lack of confidence, social stigma for sick persons-population, depression, and anxiety.

The social distancing measures have involved virtually all sectors, from tourism to restaurant, beauty salons, hairdressers, and even the public and private health systems. During the lockdown, the health system has been turned upside-down. Most of the healthcare resources have been shifted toward COVID-19 patients at the expense of other patients deemed non-urgent. This resource reallocation, in addition to COVID-19 cross infection risk and patients' anxiety of the virus (8), lead the Italian National Health Service (NHS) to provide only urgent procedures. During the lockdown period, all the non-life-threatening treatments have been temporarily suspended, including screening programs (9). This emergency decision probably did not consider the possible unintended consequences.

Millions of citizens take advantage of screening, allowing early diagnosis. Among the different programs, one of the most popular is that of breast cancer screening (10).

Breast cancer is a socially relevant disease. It is the most common cause of cancer death in the European Union which was 7% in 2016, according to Eurostat (11); in 2016, breast cancer caused 97,000 deaths in Europe and 12,000 in Italy. Screening activities have substantial positive effects in terms of reduced incidence of advanced breast cancer, loco regional recurrence and mortality along with a reduction of health care costs, measured by hospital stay, need for chemotherapy and invasive treatments (12, 13). Breast cancer is the most diagnosed oncological disease in women, involving in Italy more than 50,000 women every year (**Figure 1**). Research has largely contributed to the reduction in perspective mortality caused by breast cancer. Despite high incidence rate, during the last years there has been a substantial improvement in terms of oncological outcome with a survival rate of 87% at 5 years (14). The improvement was associated both with evolutions of treatments and earlier diagnosis due to screening (15). Breast cancer screening was introduced in Italy in the second half of the 1990s, provided to women aged 50–69 with a mammography every 2 years.

The NHS in G-7 countries devoted substantial resources to strengthen these programs also through patients' sensibilization to periodical controls (16). Over the last 30 years the number
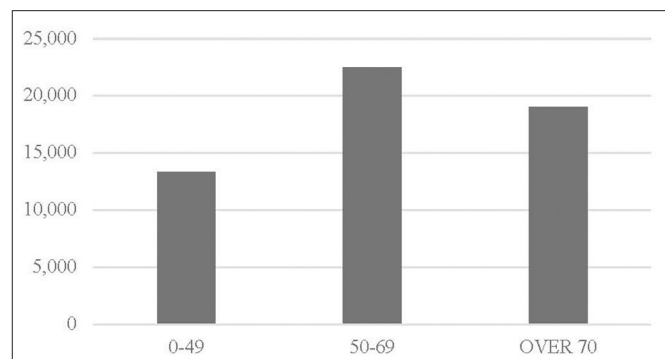
FIGURE 1 | Italian women: breast cancer by age in 2017. Source: Eurostat (11).

of screening activities has increased, and in 2017 (17) the Italian NHS provided over 4.5 million organized screenings that benefited 54.6% of women aged 50–69, while over 1.6 million women accessed voluntary screening, covering another 19.23% of women aged 50–69. Following screening activities organized by the Italian NHS, 8,257 neoplasia cases have been detected, 37% of the total (22,482). Despite over-diagnosis and overtreatment risk, screening (organized and voluntary) can diagnose ∼65% of breast cancers with negative features at clinical examination (13).

In this paper, we focus on the indirect effects of the breast cancer screening suspension. Due to temporary suspension of breast cancer screening, we will probably observe an increase in advanced breast cancer diagnosis, with a corresponding deterioration of the quality of life and oncological outcome for breast cancer patients, accompanied by an increase in health care costs. We aim to provide the scientific community with a forecast of breast cancer undetected cases, by considering two different scenarios. The Italian experience can help other countries that introduced social distancing measures to implement public health care policies within the NHS to counterbalance these adverse effects.

METHODS

Scenario analysis represents a sequence of hypothetical events with the purpose of focusing on causal points. Scenario analysis can describe possible future outcomes of the present social distancing policies. The baseline is the last year available, 2017; based on Italian female population data (17), screening performed and on the ability of screening to detect neoplasia, we forecast the undetected cases, as a consequence of the reduction of screening (18). Each month of screening suspension, ceteris paribus, leads to 1/12 reduction of screening activities and to a proportional reduction of neoplasia detection (19). We consider two alternative scenarios; the hypothesis of scenario 1 (optimistic ☺) states that organized screening activities missed during the lockdown months are not performed in the remaining months of 2020 (light blue bar), if compared with the baseline year, while voluntary screening activities (gray bar) are performed.

FIGURE 2 | Optimistic scenario (%). Source: Osservatorio Screening (17) and authors' elaboration.

FIGURE 3 | Pessimistic scenario (%). Source: Osservatorio Screening (17) and authors' elaboration.
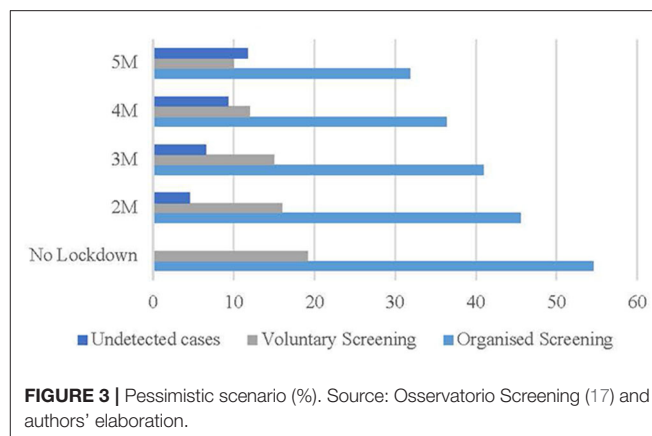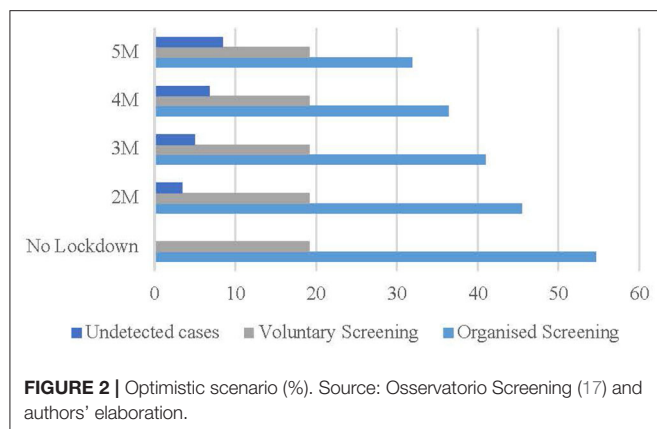
The hypotheses of scenario 2 (pessimistic ☹) are that missed organized screening activities during the lockdown months are not performed in the remaining months of 2020 (light blue bar), as well as voluntary screening activities (gray bar) if compared with the baseline year; the latter diminishes due to the significant reduction in disposable income of all households that minimize the expenses on non-urgent health care, including voluntary screening.

RESULTS

In the optimistic scenario (**Figure 2**), if the restriction on non-urgent activities lasts from the beginning of March to the beginning of May 2020, 3.43% of cases (blue bar) will not be detected. Considering longer periods, 5.01% (3 months), 6.77% (4 months), and 8.42% (5 months) of cases (gray bar) will not be detected.

The optimistic scenario is coherent with the fact that the (higher) level of income and education positively correlate with (more) voluntary screening activities (19, 20) estimated in regard to the US labor market that job and income losses due to the COVID-19 pandemic have been smaller among workers with higher level of education.

In the pessimistic scenario (**Figure 3**), if the restriction on non-urgent activities lasts from the beginning of March to the beginning of May 2020, 4.53% of cases (blue bar) will not be detected. Considering longer lockdown periods, 6.57% (3 months), 9.34% (4 months), and 11.73% (5 months) of cases (gray bar) will not be detected.

The scenario is coherent with the fact that in OECD countries women are more likely to be in temporary, part-time, and precarious employment (21). In Italy, the gender gap in the labor market is larger than 20 percentage points and the pandemic will increase the burden of home and childcare on women, due to shut down of schools and kinder-gardens.

DISCUSSION OF RESULTS

The health care lockdown in Italy has not been shorter than 4 months; only in the summer of 2020, the Italian Government

has intervened to remove the suspension of all the non-life-threatening treatments, including cancer screening. Time has key role to reduce the unintended consequences of the pandemic; the longer the health care lockdown lasts, the higher will be the final effects in terms of morbidity, mortality, and health care costs.

Many studies have attempted to estimate breast cancer growth time. Data reported in the literature estimate doubling tumor times varying from 42 to 260 days. This poor accuracy measurement, correlated with the different biological characteristics of breast tumors, is unhelpful for determining the effect of delays on the clinical presentation of breast cancer. However, we can reasonably suppose, based on (22, 23), that in 6 months up to 50% of breast cancer cases could increase tumor dimension in up to 1 cm.

After the introduction of breast cancer screening programs, we have detected a turnaround in breast cancer clinical presentation: a reduction of palpable lesions (local advance breast cancer) and an increase of un-palpable lesions (early stage) (24). Due to the temporary suspension of the screening during the lockdown, we have already observed a reduction of breast cancer diagnosis cases (9). The diagnoses that are performed during the lockdown period are of clinically evident lesions (palpable lesions, nipple discharge, cutis retraction, breast ulceration, and mastitis carcinomatosa) which correspond to about 35–40% of all breast cancer lesions (24). The reduction of breast cancer diagnoses would lead to an increase in new cases once the lockdown period ends, an increase that could undermine the cancer health system which is already experiencing a significant slowdown with a consequent growth of waiting lists (25).

Interruption and partial reduction of the public and private breast cancer screening activities can lead to detecting new cases of BC in advanced stage. Failure to early diagnoses could lead to an increase of more invasive surgery, need for further treatments such as systemic chemotherapy impacting women's quality of life, worst oncological outcomes and increased NHS costs. Data reported on US commercially insured population (22) between 2009 and 2012 (n. 8,360) showed that the costs of treating breast cancer could be reduced achieving early diagnoses and treatments: "*earlier detection of breast cancer by routine screening leads not only to reduced morbidity and mortality but also to lower costs for cancer treatment*" (p. 31).

Similar investigations are not available for the Italian population. However, in Europe treatment costs are higher for patients with advanced breast cancer.

CONCLUSION AND POLICY IMPLICATIONS

Regardless of country specific strategy to manage COVID-19 pandemic, the ability to look at the consequences of state actions beyond the remit of the current health emergency is crucial in the wider context of global policy-making (26). Key points in public health policy response are funding and patients' sensibilization.

About funding, the European recovery plan settled by the Eurogroup (27) will provide countries with liquidity, funding and flexibility on current budget rules. The EU is moving faster than we are accustomed to, and history teaches us that policy coordination is the only successful exit strategy following a systemic shock, like the COVID-19. The €6 billion Health Initiative launched by the European Commission (28) is only a starting point in the management of the emergency. Further coordinate response and funding are needed to tackle the direct and indirect consequences of the pandemic, and in particular to fill the gap in cancer screening. The size of the health care funding necessary in Italy, similarly to other European countries, depends on its medium and long-term objectives. Organized cancer screening should be considered firstly of health care managers due to it is a cost-effective mean to reduce health care costs and mortality.

About patients' sensibilization, it is very likely that screening adhesion by patients will be lower than in the pre-COVID-19 era. This is supported by three main reasons. Firstly, the Italian healthcare system may not be able to fill in the gap due to the restriction on non-urgent activities and meet the patients' demand for mammography, especially in the center and south of the country. Secondly, the social distancing measures have a substantial impact on women's income that in turn could lead to a reduction in medical expenditure (i.e., reduction of voluntary screening). The gender gap in the Italian labor market is likely to increase further following the pandemic, especially for low-skilled and uneducated women, thus the risk of poverty (20, 21).

Thirdly, patients' anxiety should not be underestimated. During the lockdown, patients with breast cancer diagnosis often refused to undergo surgery due to the COVID-19 anxiety (8, 9, 24). Therefore, a portion of women may choose not to adhere to screening campaigns in the coming months of 2020 (29).

Socio-economic and health consequences of results are relevant in both scenarios under consideration. In the optimistic scenario the undetected cases rate ranges between 5 and 8.42%. Otherwise, in the pessimistic scenario undetected cases rate raise from 6.57 to 11.53%. Impairment of early tumor detection could result in higher health care cost and worsening of long-term outcome. In our opinion, at the end of the pandemic, health care policies should be implemented within the NHS to counterbalance these unintended effects. To fill in the gap and meet patients' demands, it is necessary to re-finance regular screening within the Italian NHS. Voluntary screening should also be favored with national targeted media campaigns on newspapers, social media, radio, and the TV.

First COVID-19 outbreak was greatly overcome by Italian NHS, but cross-infection within hospital between health care workers and patients generates anxiety among workers and patients (8, 29). A nationwide informative campaign on the procedures to manage the risks of COVID-19 within the health care system and their effects could help to reduce patients' anxiety; tradition and social media campaigns, together with contact-tracing apps, like the Italian Immuni, can be employed to share relevant information among sensible citizens.

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Public Health Interventions for the COVID-19 Pandemic Reduce Respiratory Tract Infection-Related Visits at Pediatric Emergency Departments in Taiwan

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Background and objective: Public health interventions such as social distancing, wearing surgical or N95 masks, and handwashing are effective in significantly reducing the risk of infection. The purpose of this article is to analyze the effect of public health interventions on respiratory tract infection-related visits to pediatric emergency departments during the COVID-19 pandemic in Taiwan.

Method: Pediatric emergency department visits between January 1 2020 and April 30 2020 were included for trend analysis and compared to the same period during the past 3 years. The datasets were retrieved from Taiwan National Infectious Disease Statistics System and Kaohsiung Chang Gung Memorial Hospital. Respiratory tract infections with other diagnoses categories, including fever, asthma, and urinary tract infections, were included for subgroup analysis.

Result: A significant decrease of more than 50% in respiratory tract infection-related visits was found from February to April 2020 in the national database. With regard to diagnosis category, the proportion of respiratory tract infections in Kaohsiung Chang Gung Hospital also became significantly lower in 2020 during the months of March (43.4 vs. 37.4%, $p = 0.024$) and April (40.1 vs. 32.2%, $p < 0.001$). On the other hand, the proportion of urinary tract infections was significantly higher in 2020 during March (3.7 vs. 5.2%, $p = 0.033$) and April (3.9 vs. 6.5%, $p < 0.001$), and that of asthma was also higher in April (1.6 vs. 2.6%, $p = 0.025$). Furthermore, the intensive care unit admission rate was relatively higher in 2020 from February, with significant differences noted in March (1.3 vs. 2.8%, $p < 0.001$).

Conclusion: Due to public health interventions for the COVID-19 pandemic, the transmission of not only COVID-19 but also other air droplet transmitted diseases in children may have been effectively prevented.

Keywords: public health interventions, social distancing, wearing masks, handwashing, respiratory tract infection, COVID-19, pediatric emergency department, SARS-CoV-2

INTRODUCTION

Coronavirus Disease 2019 (COVID-19) has emerged as a new infection (1, 2) and began infiltrating modern society from the beginning of 2020 (3, 4). Its rapid local and international spread, in addition to its ability to infect large numbers of crowds, including health care professionals, some of whom required intensive care, has generated considerable media attention (5). Emergency departments (EDs) around the world have been flooded by patients suspected of having the coronavirus infection. However, while frontline health care workers have been exhausted handling COVID-19 patients, ED visits related to non-coronavirus illnesses fell drastically during the same period. This scenario reflects the same situation in 2004, where studies from that time demonstrated a decrease of up to 50% of ED visits during the SARS epidemic (6, 7). Parents may have been avoiding the hospital because it presents the greatest risk of exposure to the virus, raising concerns about the aerosolized spread of the virus by being exposed to other coughing respiratory patients and aerosol-generating procedures (8, 9). Furthermore, parents may view the hospital as a risky location and are unaware of the cleaning precautions or screening methods that have been adopted (10). This decline was interpreted as "COVID-phobia," where patients were assumed to be avoiding hospitals due to a fear of contracting the COVID-19 infection while visiting the ED. However, public health interventions for the COVID-19 pandemic also play an important role in non-coronavirus illnesses. Steps for epidemic control, including wearing face masks, washing hands, and social distancing, have been well-executed among the general worldwide population.

During the COVID-19 pandemic, Taiwan has so far been able to protect the interests of its citizens thanks to rapid alerts and by following emergency management activation (11, 12). We believe that such measures not only inhibited the transmission of the COVID-19 infection but also other contagious diseases (13), especially for the pediatric population, where infectious diseases account for 80% of ED visits (14). One study has shown that maintaining social distance and wearing surgical or N95 masks are both effective methods for significantly reducing the risk of infection as droplets are generated at the face level, which made masks crucial for protection during the SARS epidemic (15). Furthermore, handwashing has long been regarded as a vital and cost-effective infection-control practice against the transmission of SARS and other respiratory contagious diseases in health care and community settings (16). Therefore, the aims of this study are to analyze the effect of public health interventions on respiratory tract infection (RTI)-related visits to pediatric EDs during the COVID-19 pandemic in Taiwan.

METHODS

Patient Population

In this study, we first included the dataset from Taiwan's National Infectious Disease Statistics System on the Taiwan Centers for Disease Control public website for trend analysis regarding RTI-related visits nationally (17). And we further analyze disease specific pediatric ED visits from the electric medical records of Kaohsiung Chang Gung Memorial Hospital, one of the largest medical centers in southern Taiwan, to address the effect of public health intervention on common pediatric ED diagnosis. In this study, pediatric ED visits during January 1 2020 and April 30 2020, were included for trend analysis and were compared with the same period during the past 3 years. We established the end of January as the turning point for distinguishing the changing number of ED visits based on the timeline of COVID-19 in Taiwan, in which the first confirmed case of COVID-19 was diagnosed on January 21 2020 and face mask rationing began February 6 2020 (18).

Data Collection

Outcome variables included for comparison were total number of pediatric ED visits, rate change of common pediatric ED diseases, and patient's disposition during studied period. Common pediatric infectious diseases include fever and RTI-related visits were enrolled for analysis. And although no apparent literature has elaborated on the direct relationship between epidemic prevention policies and conditions like asthma and urinary tract infection (UTI), we have observed that trends of these two disease diagnosis demonstrated no reduction during the last pandemic period when personal protective measures were adopted to reduce pandemic influenza transmission in 2009 in the US (19–21). Therefore, we also included asthma and UTI as outcome variables and hypothesized that these diseases' prevalence should be less associated with epidemic prevention policies.

Data of RTI-related visits were directly retrieved from database of Taiwan Centers for Disease Control public website. And for disease associated specific ED visit, we used the International Classification of Diseases, 10th revision (ICD-10) codes to retrieve included diseases directly from studied hospital's administrative database. We defined fever as R509, UTI as N390 and asthma as J4520-J45998. RTI-related visits were collected from ICD-10 codes R05 (cough), J00-J219 (respiratory tract infection) and were confirmed by history and image study. Non-existent or unutilized ICD-10 codes between the above diagnosis categories were skipped or abandoned after carefully examining all details in the electronic charts. Patients' disposition were collected as secondary outcomes, including pediatric intensive unit admission and general ward admission were considered for further analysis.

Statistical Analysis

All values in the figures and tables are expressed as mean ± standard deviation. Quantitative data were analyzed using the t-test or one-way analysis of variance with tukey's HSD test as *post hoc* test when appropriate. Two-sided p-values <0.05 were considered statistically significant. All statistical analyses were performed using SPSS statistical software (SPSS for MAC, version 22; SPSS). All patients' records and information were anonymized and de-identified prior to review and analysis. The institutional review board of the Chang Gung Medical Foundation approved this study (IRB number: 202000840B0).

RESULTS

RTI-Related Pediatric ED Visits During January to April From 2017 to 2020 in Taiwan

First, we observed cases of RTI-related visits drop by approximately 50%, from 49.9 to 25.7 per 10,000 people, since the 2nd week in February, compared to the average over the past 3 years (**Figure 1**) in the nation-wide database (22). In March and April, the decreased patient numbers were more obvious compared to previous years (March: 33.3–14.3, April: 32.9–13.6 per 10,000 people).

Daily Pediatric ED Visits During January to April From 2017 to 2020 in Studied Hospital

We compared the trends of pediatric ED visits in studied Hospital, including number of visits and ratio over the past 3 years. **Table 1** shows the average ED visits per day during January to April from 2017 to 2020 by month. At studied Hospital, we also observed statistically significant differences between group averages during February to April (all $p < 0.001$), but not in January ($p = 0.097$) in ANOVA analysis. Apart from 2020, ED visits among 2017, 2018, and 2019 appear to be homogenous. After *post hoc* test applied, daily ED visits of 2017 were higher than 2019 (94 ± 40.5 vs. 73 ± 16.5, $p = 0.042$) in January. On February, ED visits in 2020 were significantly lower than other 3 years (41 ± 11.4, $p < 0.001$), while visits in 2017 were also lower than visits in 2018 (73 ± 18.0 vs. 109 ± 62.1, $p = 0.017$). Afterward, daily ED visits of 2020 were both lower than other 3 years in March (30 ± 7.2, $p < 0.001$) and April (29 ± 7.7, $p < 0.001$). The result is displayed in **Table 1**. We also demonstrated the number of ED visits per day in specific diagnosis categories from 2017 to 2020 presented in mean value and noted that all of the diagnosis-related visits dropped significantly from February 2020 (**Figure 2**).

Disease Classification During January to April From 2017 to 2020

Regarding changes to ED visits for the selected diagnoses, we found that the proportion of ED visits among diagnoses showed no statistical differences between 2020 and 2017–2019 in January and February (**Table 2**). As time passed, the proportion of RTI became significantly lower in 2020 in March (43.4% vs. 37.4%, $p = 0.024$) and April (40.1% vs. 32.2%, $p < 0.001$). The proportion of UTI was significantly higher in 2020 in March (3.7% vs. 5.2%, $p = 0.033$) and April (3.9% vs. 6.5%, $p < 0.001$), and that of asthma was also higher in April (1.6% vs. 2.6%, $p = 0.025$). When we look closely into the analysis of the total and ICU admission ratios, the total admission ratio, including the general ward and ICU, demonstrated an elevation trend since March. Notably, the ICU admission rate was relatively higher in 2020 from February with significant differences noted in March (1.3% vs. 2.8%, $p < 0.001$). On the other hand, we observed no statistically significant monthly differences in admission rate between 2020 and the past 3 years.

DISCUSSION

In this study, we first observed a nationwide trend of RTI-related pediatric ED visit dropping by ~50% after executing mask policies in response to the COVID-19 pandemic, when compared to the average over the past 3 years (**Figure 1**). Like many other countries in the world, a dramatic decline of ED visits has occurred since the beginning of the pandemic, particularly in February 2020. All these phenomena may be related to a number of reasons. One of the factors may be the so-called COVID-phobia (23) that may make parents anxious about bringing their sick children to the hospital. The relationship between COVID-19-phobia and the decline in patient volume was also observed in our study.

The other factor may be the benefit from the efficient implementation of public health interventions, including wearing face masks, washing hands, and social distancing in Taiwan. Since contagious and infectious diseases make up the great majority of pediatric emergency department cases, similar results were found when we compared the trends of pediatric ED visits. Therefore, we further reviewed visit data from the pediatric emergency department at Kaohsiung Chang Gung Memorial Hospital before and during the COVID-19 pandemic to help differentiate other reasons for the drop in visits. The volume of patients presenting to KCGMH pediatric emergency department dropped significantly by more than 50% among all diagnostic categories since February while struggling with the COVID-19 pandemic. The ratio of ICU admission in February 2020, though not statistically significant compared to the period of 2017–2019, rose from 0.9–1.9% since critically ill patients are urged to seek medical help under life threatening conditions regardless of their fear of contracting a respiratory contagious disease. This trend can be verified by epidemiologic analysis (24) and annual total admission amount calculation (25) during the 2009 H1N1 pandemic in the US.

It is worth mentioning that the ratio of ICU and general ward admissions in January 2020 was lower than in 2017–2019. The main reason is that, according to the lunar calendar, Taiwan was celebrating Chinese New Year in January 2020. The Chinese New Year festival influences patients and their parents' behavior in seeking health care. In Taiwan, the Chinese New Year festival lasts for 1 week. All the local medical clinics are closed during this week, and patients can only seek medical assistance through the ED. This phenomenon results in an increase in non-urgent ED visits during Chinese New Year. Furthermore, the ratio of ICU admissions in March 2020 was much higher than the average. The major reason was that total pediatric ED visit volume significantly decreased, which elevated the ratio of ICU admissions in March 2020. Another hypothesis could be delayed medical treatment due to population panic over the COVID-19 pandemic, as we traced the COVID-19 timeline in Taiwan, recording the first death on 16 February and confirming the 100th case on 18 March (**Figure 1**). This phenomenon of delayed medical intervention was also observed in the adult emergency department (26). It is understandable that parents

FIGURE 1 | Comparison of respiration tract related pediatric ED visit per 10,000 population between 2017, 2018, 2019, and 2020 in Taiwan.
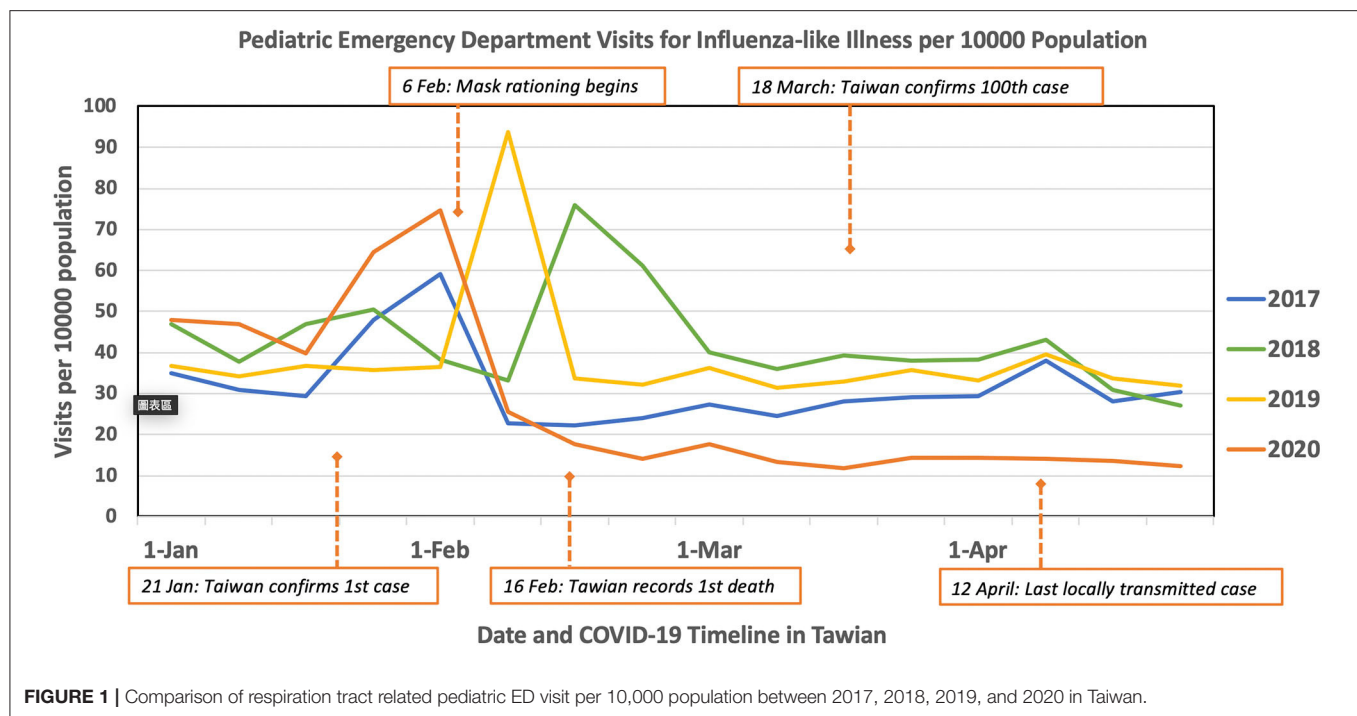
TABLE 1 | Comparison of ED visits per day during the period of January to April from 2017–2020 at Kaohsiung Chang Gung Memorial Hospital.

	January		February		March		April	
	Mean ± SD	p-value	Mean ± SD	p-value	Mean ± SD	p-value	Mean ± SD	p-value
2017	94 ± 40.5[a]	0.097	73 ± 18.0[c]	<0.001	72 ± 16.2	<0.001	73 ± 21.7	<0.001
2018	87 ± 23.9		109 ± 62.1		85 ± 20.4		77 ± 19.7	
2019	73 ± 16.5[a]		100 ± 46.4		78 ± 23.0		78 ± 17.0	
2020	88 ± 36.3		41 ± 11.4[b]		30 ± 7.2*		29 ± 7.7*	

[a]daily ED visits of 2017 were higher than 2019 (94 ± 40.5 vs. 73 ± 16.5, p = 0.042).
[b]daily ED visits in 2020 were significantly lower than other 3 years (41 ± 11.4, p < 0.001).
[c]daily ED visits in 2017 were lower than visits in 2018 (73 ± 18.0 vs. 109 ± 62.1, p = 0.017).
*daily ED visits of 2020 were both lower than other 3 years in March (30 ± 7.2, p < 0.001) and April (29 ± 7.7, p < 0.001).
Bold text indicates a statistically significant difference with a p-value less than 0.05.

have been reluctant to bring their children to a hospital during the COVID-19 outbreak, thus explaining the potential delays in seeking care.

The ratio of asthma, which we classified as a non-contagious disease, was not significantly higher from March, as we expected; the same was true of urinary tract infections. Multiple factors may contribute to this result. First, COVID-19 is a global pandemic and a serious threat to human health that has halted economic activities, thus reducing air pollution and reclaiming nature (27). Young children with asthma are particularly susceptible to air pollution due to their developing lungs, immature metabolic pathways, high breathing rates per bodyweight, and amount of time spent exercising outdoors (28). Therefore, young children may actually benefit from this phenomenon. Furthermore, asthma, though not a contagious disease, may also benefit from wearing

masks. It is most likely that the face mask may make it easier for the wearer to maintain a normal body temperature, while the airway mucosa is protected from cooling and dehydration, two factors that may cause an increased incidence of asthma (29).

One of the main results in this study demonstrates that UTI could be considered a "panic phenomenon" that reflexes people's medical attention-seeking mentality. A lower ratio was noted in January and February in 2020 at the beginning of the pandemic. After people in Taiwan regained confidence in the government's pandemic prevention measures (30) and were willing to seek medical advice, we saw the last locally confirmed transmitted case on 12 April (**Figures 1**, **2**). The ratio of UTI, which is classified as a non-contagious disease based on its epidemiology and pathogenic mechanism (31), has been significantly higher since March 2020. The ratios of hospital

FIGURE 2 | Comparison of average visits from 2017 to 2019 and for 2020 at Kaohsiung Chang Gung Memorial Hospital. **(A)** Total visits at pediatric emergency department. **(B)** Pediatric emergency department visits in categories. PED, pediatric emergency department; RTI, respiratory tract infection; UTI, Urinary tract infection.
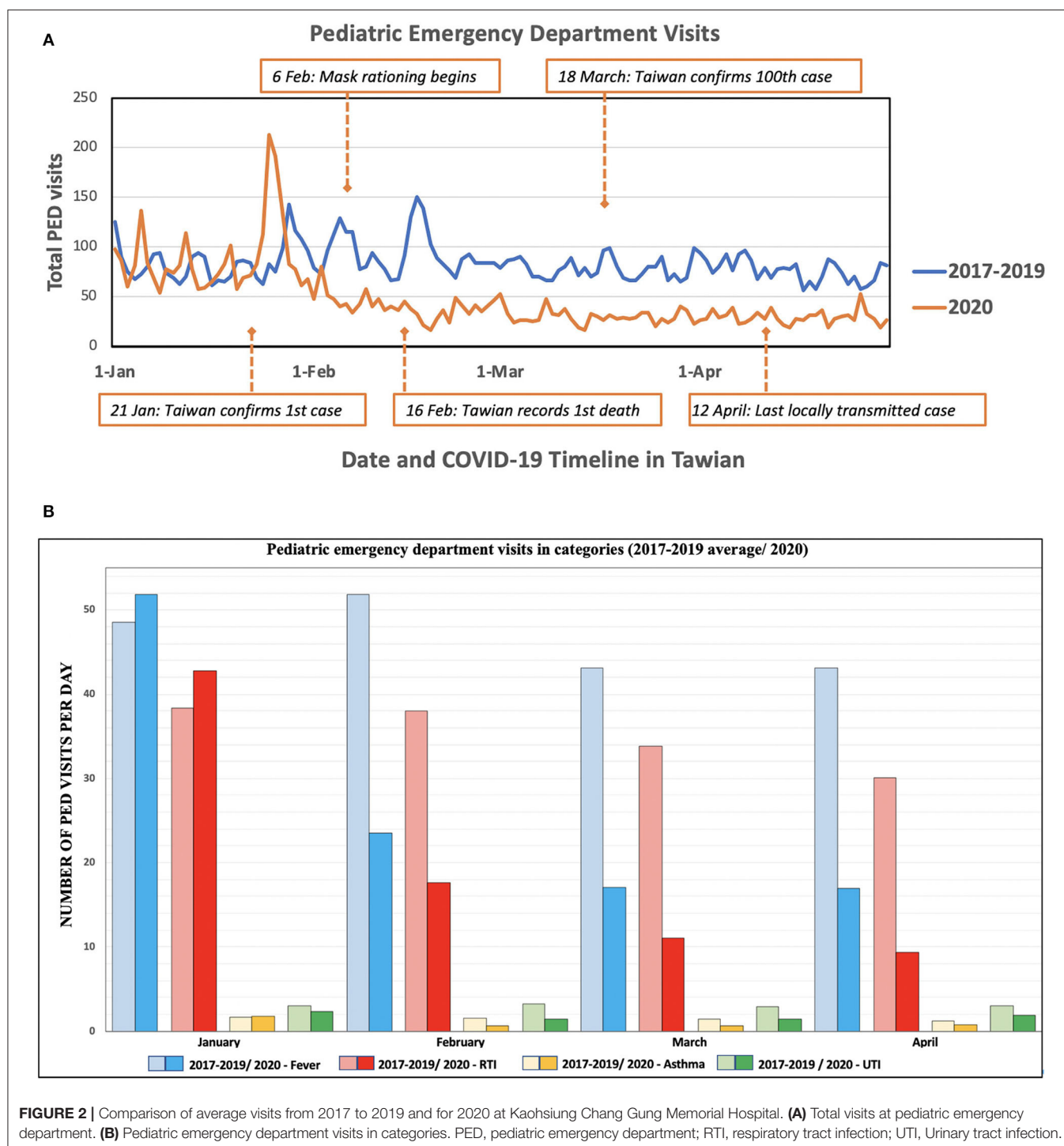
admission reached a general level in April 2020 after people regained confidence in the government and hospitals' pandemic prevention measures. No further locally transmitted case has been reported since 12 April 2020 in Taiwan, as demonstrated in both **Figures 1**, **2**.

The most important result of our study indicates a robust connection with the government's policies. Due to relevant policies (mask rationing on 6 February in Taiwan) and their

mandated and comprehensive execution, not only did RTI-related cases in KCGMH reflect statistical significance, but the trend of RTI in Taiwan also showed obvious declines (32). Our pediatric emergency department experienced a significantly reduced proportion of RTI patients in 2020 in March (37.4%) and April (32.2%) compared to the ratio in January (48.3%). We believe this result may be attributed to the triad of public health interventions in Taiwan (33),

TABLE 2 | Number of ED visits and ratio (%) regarding diagnosis and patient disposition at Kaohsiung Chang Gung Memorial Hospital.

	January			February			March			April		
	17–19	2020	*p*-value	17–19	2020	*p*-value	17–19	2020	*p*-value	17–19	2020	*p*-value
Total ED visits	7845	2745		7888	1176		7231	921		6869	875	
Diagnosis												
Fever	4519 (58.6)	1607 (58.5)	0.658	4343 (55.1)	682 (58.0)	0.315	4010 (55.5)	529 (57.4)	0.545	3876 (56.4)	510 (58.3)	0.584
RTI	3570 (45.5)	1326 (48.3)	0.126	3191 (40.5)	510 (43.4)	0.223	3140 (43.4)	344 (37.4)	*0.024*	2754 (40.1)	282 (32.2)	*<0.001*
Asthma	158 (2.0)	54 (2.0)	0.883	133 (1.7)	17 (1.4)	0.972	135 (1.9)	22 (2.4)	0.288	108 (1.6)	23 (2.6)	*0.025*
UTI	275 (3.5)	74 (2.7)	0.057	277 (3.5)	43 (3.7)	0.809	268 (3.7)	48 (5.2)	*0.033*	268 (3.9)	57 (6.5)	*<0.001*
Disposition												
Admission	1638 (20.9)	522 (19.0)	0.089	1432 (18.2)	245 (20.8)	0.069	1634 (22.6)	231 (25.1)	0.184	1623 (23.6)	191 (21.8)	0.348
ICU admission	92 (1.2)	25 (0.9)	0.263	101 (1.3)	22 (1.9)	0.108	95 (1.3)	26 (2.8)	*<0.001*	79 (1.1)	15 (1.7)	0.157

RTI, Respiratory Tract Infection; UTI, Urinary Tract Infection; ICU, Intensive Care Unit.
Bold text indicates a statistically significant difference with a p-value less than 0.05.

which include wearing face masks, washing hands, and social distancing.

Our study has several limitations that should be mentioned at this point. First, it was conducted in a single and pediatric tertiary care emergency department, so the generalizability of these findings is limited to comparable institutions. Second, how the public used the pediatric emergency department during the COVID-19 outbreak may not reflect future use. However, we still found that a lower ratio of respiratory tract infection, with regard to air droplet transmitted diseases, has a correlation with epidemic prevention in both the national database and the studied hospital. Urinary tract infections, defined as a non-contagious disease and "panic phenomenon," strongly reflect people's medical-seeking mentality.

In conclusion, we believe that the decline in pediatric ED visits may partly come from panic. However, our study has also shown that the triad of public health interventions for the COVID-19 pandemic may have effectively prevented the transmission of not only COVID-19 but also other air droplet transmitted diseases in children.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The institutional review board of the Chang Gung Medical Foundation approved this study (IRB number: 202000840B0).

AUTHOR CONTRIBUTIONS

C-FL, I-MC, and Y-HH: conceptualization. C-FL and I-MC: data curation, formal analysis, investigation, methodology, and Writing - original draft. I-MC: Project administration. C-YC, K-HW, and Y-HH: Resources. C-FL, C-YC, and Y-HH: Software. K-HW, Y-HH, K-ST, and I-MC: Supervision. Y-HH and I-MC: Validation. C-FL, I-MC, and Y-HH: Visualization and Writing - review and editing. All authors contributed to the article and approved the submitted version.

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Perceived Effectiveness, Safety, and Attitudes Toward the Use of Nucleic Tests of SARS-CoV-2 Among Clinicians and General Public in China

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Objective: To assess whether there is a knowledge gap about the use of test kits for residents and to explore the knowledge, attitudes, and practices of using test kits in China during the coronavirus disease 2019 (COVID-19) epidemic. Method: An online-based, nationwide, and cross-sectional study was conducted. A total of 1,167 respondents were recruited from June 19 to July 2, 2020. All participants completed a validated questionnaire written in Chinese. Electronic consent was obtained from all participants upon their agreement to commence the questionnaire. Perceived efficacy, safety, and their attitudes toward the use of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) testing kits were measured.

Result: The majority of the study respondents were female [749 (64.2%)], aged 31–40 years old [372 (31.9%)], and located in mainland China [1,137 (97.4%)]. The majority of the respondents held a positive view toward the introduction of the fast-track approval policy for novel coronavirus testing products (6.16 ± 1.30) as well as toward putting more investment in scientific research and biomedicine to improve the detection accuracy of detection kits (5.94 ± 1.55) in China. The respondents valued the detection accuracy more as opposed to the detection time of the testing kits (4.66 ± 2.00), whereas few participants agreed that in the research and development process, detection accuracy could be sacrificed to speed up production and coverage capacity (3.02 ± 2.04).

Conclusion: The majority of the participants have a basic knowledge of the detection methods of the SARS-CoV-2 virus and the types of test kits, as well as great confidence in China's domestic production of test kits and decisions. However, how basic knowledge, high compliance, and positive attitudes play a role in easing the tension of the pandemic still remains unknown.

Keywords: COVID-19, test kits, questionnaire, Likert scale, nucleic test

INTRODUCTION

With the fast spread of the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), coronavirus disease 2019 (COVID-19) has infected more than 16.6 million people and caused nearly 0.66 million deaths globally, according to the WHO report as of the end of July 2020 (1). Currently, no specific medicine has shown both efficacy and safety in the treatment of COVID-19 (2). Vaccines specifically targeting the viral spike protein or RNA in the market for COVID-19 prevention are still under development (3), while the transmissive ability of SARS-CoV-2 continues to increase with the mutation of the *D614G* gene on the spike protein (4). Therefore, suppression and mitigation strategies, including mask-wearing, social distancing, and quarantining suspected and confirmed cases, are still the major methods to control the spread of the virus (5, 6).

It is essential to distinguish between asymptotic, suspected, or confirmed cases of COVID-19 before quarantine. One who has been exposed to SARS-CoV-2 and has developed symptoms of COVID-19, such as cough, fever, fatigue, etc., is considered as a suspected case and is therefore in need of further identification (7). So far, hundreds of testing kits have been available in the market to meet the exponential demand in testing, targeting antigens, antibodies [immunoglobulin G (IgG) and immunoglobulin M (IgM)], and the viral RNA of SARS-CoV-2 to confirm infection (8, 9). However, antigen tests rarely produce ideal results, and antibody tests generate results that fluctuate in accordance with age, severity, and the time after the manifestation of symptoms. In addition, RNA testing, at times, lacks accuracy as well. For testing kits targeting the RNA of SARS-CoV-2, the sample is often taken from the nose or the throat (10). After undergoing reverse transcription polymerase chain reaction (RT-PCR) in the laboratory, the sample is augmented and cross-matched with the sample to verify the existence of RNA of SARS-CoV-2 (11). However, studies have shown that some COVID-19 patients tested positive again after discharge, and that multiple false-negative RT-PCR-related results were suspected to be related to prolonged nucleic acid transformation time rather than the recurrence of the infection (12). Data from the US show that after testing negative using the RT-PCR, 3.5% of the tested population tested positive in another subsequent RT-PCR test (13). Hence, research suggests that it is optimal to combine the serological total-antibody count and the RT-PCR test to get an enhanced sensitivity of 98.6% and specificity of 98.7% (14).

Since the testing kit is used to identify infected populations, the knowledge, attitude, and practices (KAP) of the residents on testing kits is of utmost importance during the testing process. Current KAP research on COVID-19 is focusing on healthcare workers or the general public in different countries, such as China, the US, and Iran (15–25), or studying personal protective equipment (PPE), namely, face masks, and other non-pharmaceutical interventions (26). In our previous study, we investigated the KAP and compliance with the use of face masks in China and found that most of the respondents showed good basic knowledge on the use of face masks and a good sense of self-protection (Ruirui L et al., Knowledge, Attitude, Practice, and Compliance with the Use of Masks in China against the Current

TABLE 1 | Baseline characteristics.

Baseline characteristics	Value
N	**1,167**
Gender	
Male	418 (35.8%)
Female	749 (64.2%)
Age group	
<20	36 (3.1%)
20–30	344 (29.5%)
31–40	372 (31.9%)
41–50	293 (25.1%)
51–60	101 (8.7%)
>60	21 (1.8%)
Current location	
Mainland China	1,137 (97.4%)
Hong Kong, Macau, and Taiwan	17 (1.5%)
Overseas	13 (1.1%)
Education level	
Below senior high school	111 (9.5%)
Undergraduate	636 (54.5%)
Graduate and above	420 (36.0%)
What role do you play in the process of implementing the SARS-CoV-2 test kit in the general population?	
R&D personnel	15 (1.3%)
Production personnel	7 (0.6%)
Sales personnel	19 (1.6%)
Healthcare workers (do not operate directly)	466 (39.9%)
Healthcare workers (operate directly)	17 (1.5%)
Ordinary people being tested	643 (55.1%)

Challenging Pandemic: A Nationwide Cross-sectional Survey, 2020). To our best knowledge, no research has been conducted on the KAP of the general population on testing kits so far. Also, owing to the possible convenient sampling and the fact that the healthcare works or the testing-kits-related occupation may cause false positive or biased results, a nationwide, web-based, cross-sectional survey was conducted in different groups of Chinese residents on COVID-19 diagnosis, knowledge, and confidence on testing kits and personal opinions on specific questions.

METHODS

Study Design and Population

This is a nationwide, web-based, cross-sectional study. A total of 1,167 respondents were recruited from June 19 to July 2, 2020. All participants completed a validated questionnaire written in Chinese. Electronic consent was obtained from all participants upon their agreement to commence the questionnaire. Perceived efficacy, safety, and their attitudes toward the use of a testing kit of SARS-CoV-2 were measured.

Study Tool

The survey questionnaire was designed in Chinese and translated to English. Two experts were asked to review the questionnaire

TABLE 2 | The perceived knowledge of the use of testing kit for SARS-CoV-2.

Factor	
N	**1,167**
How do you identify a suspect of COVID-19?	
(Had been in close contact with COVID-19 infected patients)	863 (74.0%)
(There are fever patients in the family)	403 (34.5%)
(Have fever and respiratory symptoms)	592 (50.7%)
(Blood routine white blood cells are normal or low, lymphocytes are low, chest CT shows typical characteristics of viral pneumonia)	716 (61.4%)
(The inspection found that the COVID-19 nucleic acid, antigen, and antibody tests were positive)	939 (80.5%)
(Do not understand)	40 (3.4%)
Which means of COVID-19 detection have you heard of during this pandemic?	
(Nucleic acid test)	1,137 (97.4%)
(Antigen test)	317 (27.2%)
(Antibody test)	523 (44.8%)
(Never heard of the above three)	31 (2.7%)
Which means of COVID-19 detection have you used during this pandemic?	
(Nucleic acid test)	758 (65.0%)
(Antigen test)	83 (7.1%)
(Antibody test)	169 (14.5%)
(Never heard of the above three)	410 (35.1%)
According to your knowledge, how long does it take to complete a coronavirus nucleic acid test?	
(In 5 min)	44 (3.8%)
(5–30 min)	109 (9.3%)
(30–60 min)	100 (8.6%)
(1–12 h)	350 (30.0%)
(12–24 h)	290 (24.9%)
(More than 24 h)	239 (20.5%)
(Do not understand)	183 (15.7%)
What is the perceived accuracy rate of the nucleic acid test in China?	
(Below 30%)	26 (2.2%)
(30–60%)	175 (15.0%)
(60–90%)	349 (29.9%)
(Above 90%)	378 (32.4%)
(Do not understand)	284 (24.3%)
Which of the following products have you heard of or used?	
[SARS-CoV-2 nucleic acid detection kit (fluorometric real-time PCR)]	535 (45.8%)
[SARS-CoV-2 nucleic acid detection kit (thermostatic amplitude-real-time fluorescence method)]	173 (14.8%)
[SARS-CoV-2 nucleic acid detection kit (hybrid capture immunofluorescence method)]	112 (9.6%)
[SARS-CoV-2 nucleic acid detection kit (RNA capture probe method)]	130 (11.1%)
[SARS-CoV-2 nucleic acid detection kit (combined probe—anchored polymerization sequencing method) and supporting instruments and software]	97 (8.3%)

(Continued)

TABLE 2 | Continued

Factor	
N	**1,167**
[Six respiratory virus nucleic acid detection kits (thermostatic amplification chip method) and supporting instruments]	102 (8.7%)
(Have not heard of any of these)	507 (43.4%)
How long do you think the nucleic acid test/serology test takes?	
(in 5 min)	38 (3.3%)
(5–30 min)	114 (9.8%)
(30–60 min)	139 (11.9%)
(1–12 h)	232 (19.9%)
(12–24 h)	172 (14.7%)
(Above 24 h)	167 (14.3%)
(Do not understand)	417 (35.7%)
From your understanding, what is the current accuracy of antigen/antibody detection?	
(Below 30%)	29 (2.5%)
(30–60%)	116 (9.9%)
(60–90%)	281 (24.1%)
(Above 90%)	333 (28.5%)
(Do not understand)	457 (39.2%)
Which antigen/antibody detection tests have you used before?	
(Colloidal gold products)	230 (19.7%)
(Magnetic particle chemiluminescence products)	89 (7.6%)
(None of them)	897 (76.9%)
Which means of testing would you prefer, an antigen detection kit, antibody detection kit, or a nucleic acid detection kit?	
(Antigen detection kit)	66 (5.7%)
(Antibody detection kit)	105 (9.0%)
(Nucleic acid detection kit)	612 (52.4%)
(I am not sure)	384 (32.9%)
Do you think the testing kit is feasible for screening normal people?	
(Yes, it is feasible)	854 (73.2%)
(No, it is not feasible)	105 (9.0%)
(I am not sure)	208 (17.8%)
Personally, do you trust a non-professional operating the testing kits?	
(Yes, I do)	210 (18.0%)
(No, I do not)	795 (68.1%)
(I am not sure)	162 (13.9%)
Which sampling method do you think is the most accurate?	
(Throat swab)	955 (81.8%)
(Nasopharyngeal swab)	661 (56.6%)
(Anal swab)	137 (11.7%)
(Sputum)	323 (27.7%)
(Bronchoalveolar lavage fluid)	324 (27.8%)
(Saliva)	167 (14.3%)
(Blood)	343 (29.4%)
(Urine)	80 (6.9%)
(Do not understand)	92 (7.9%)

FIGURE 1 | Distribution of responses to the question, "How to identify COVID-19."

FIGURE 2 | Distribution of responses to the question, "Which means of detection have you heard of."
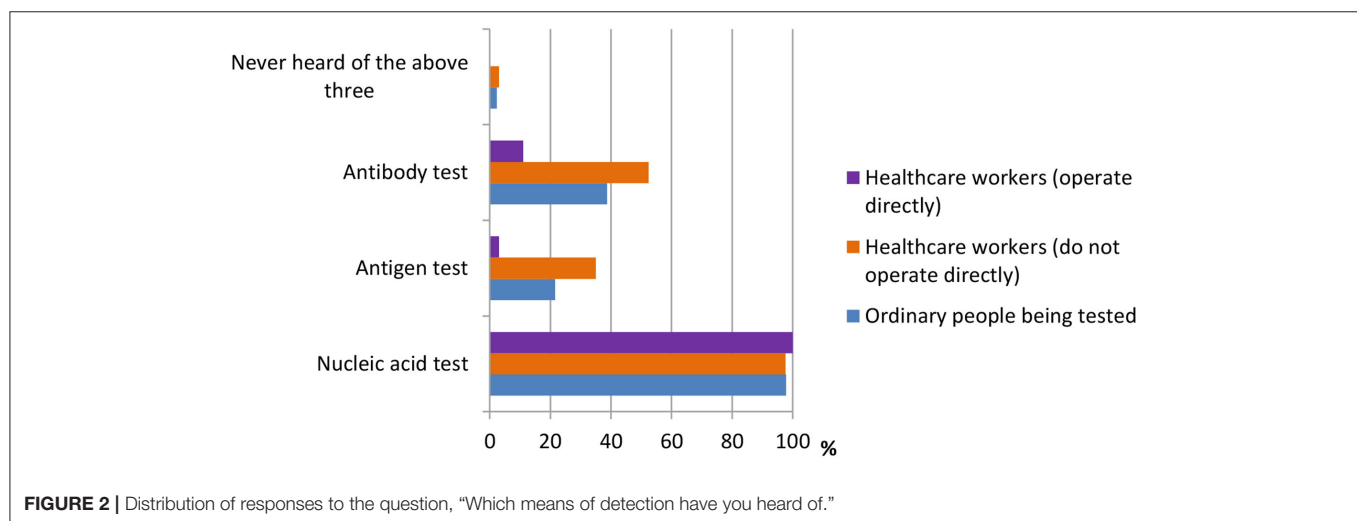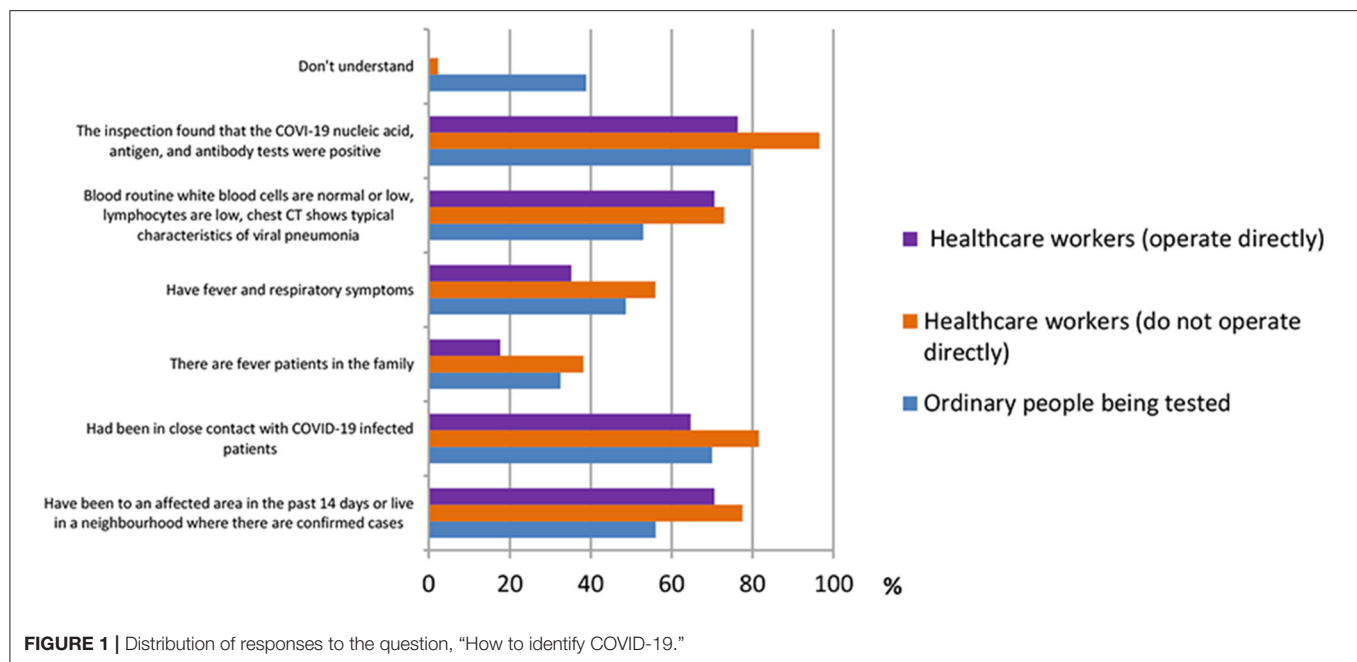
in order to make sure that it reflected the knowledge and attitude of the Chinese population on the use of the COVID-19 testing kit. Accordingly, the questionnaire was further modified to meet the aim required. In the questionnaire, single-choice, multiple-choice, and Likert 7-point scales were used. Following an informative consent form, the final closed-ended questionnaire consisted of 22 questions. The questionnaire was divided into three sections: (1) 13 questions for the perceived knowledge of the use of testing kits for SARS-CoV-2, (2) 5 questions for the attitudes toward the use of testing kits for SARS-CoV-2, and (3) 4 questions for the Likert scale of attitudes toward the use of testing kits for SARS-CoV-2. The internal reliability (KR-20) for this questionnaire was 0.80, and the Kaiser–Meyer–Olkin measure of sampling adequacy was 0.632.

Data Collection

The participants were recruited *via* peer referral in the selected cohorts, and data were collected using an anonymous online questionnaire survey platform powered by *WenJuanXing* (www.wjx.cn). The questionnaires were distributed *via* WeChat, a Chinese cell/web app for messaging, social media, and communications, where a unique two-dimensional code directing to the questionnaire was sent to the potential participants. The data of the questionnaire would be collected only if the entire questionnaire was finished.

Statistical Analysis

The questionnaire established strata by age group (<20, 20–30, 31–40, 41–50, 51–60, or >60 years), sex (male or
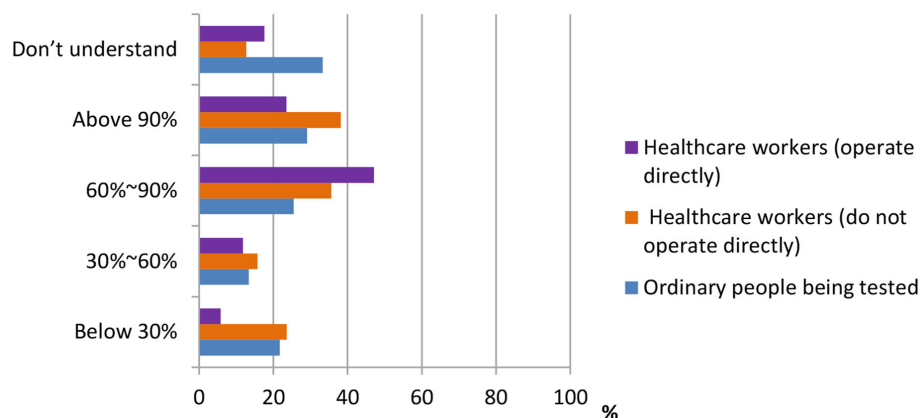
FIGURE 3 | Distribution of responses to the question, "Preceived accuracy rate of nucleic acid test in China."
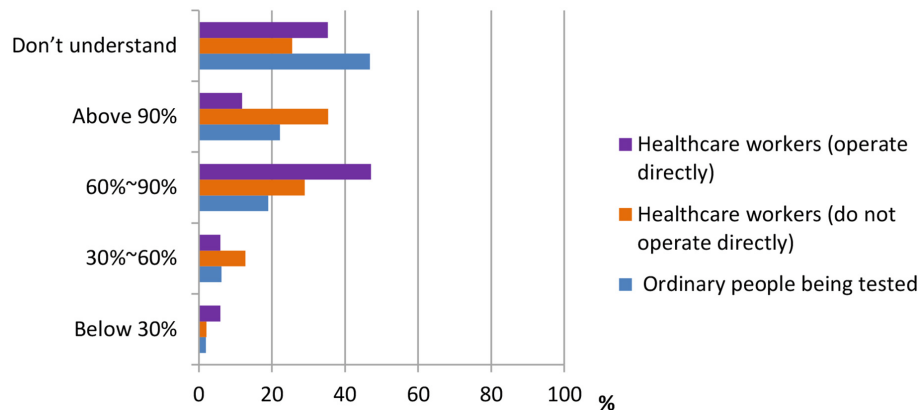
FIGURE 4 | Distribution of responses to the question, "Current accuracy of antigen/antibody detection."

female), current location (Mainland China, Hong Kong, Macau, Taiwan, or Overseas), education level (below senior high school, undergraduate, or graduate and above), and the role they played in the process of implementing the SARS-CoV-2 test kit in the general population (R&D personnel, production personnel, sales personnel, healthcare workers who do not operate directly, healthcare workers who operate directly, or ordinary people being tested).

The data obtained from the participants were analyzed using Stata MP 14.0 (Stata Corp., USA). Means with standard deviations were calculated for continuous variables and frequency with percentages for categorical variables. No sampling weights were used. Knowledge scores were compared using an independent sample t-test for differences in mean score between two groups of variables, and analysis of variance (ANOVA) was used for comparison between multiple groups. A P-value < 0.05 was considered significant.

RESULTS

Descriptions of Demographics of the Respondents

A total of 1,167 results were analyzed in the study. The baseline characteristics were shown in **Table 1**. The majority of the study respondents were female [749 (64.2%)], aged 31–40 years old [372 (31.9%)], and located in Mainland China [1,137 (97.4%)]. Undergraduate respondents contributed most [636 (54.5%)], and the main population of participants being tested was ordinary people [643 (55.1%)].

The Perceived Knowledge of the Use of a Testing Kit for SARS-CoV-2

A total of 13 questions were designed in this section. The questions were shown in **Table 2**. According to the results shown in **Figure 1**, many people had different thoughts about the identification of COVID-19. The result was classified into three groups, namely, ordinary people being tested (OP), healthcare

FIGURE 5 | Distribution of responses to the question, "Which of the following products have you heard of or used."

FIGURE 6 | Distribution of responses to the question, "Which sampling method is the most accurate."
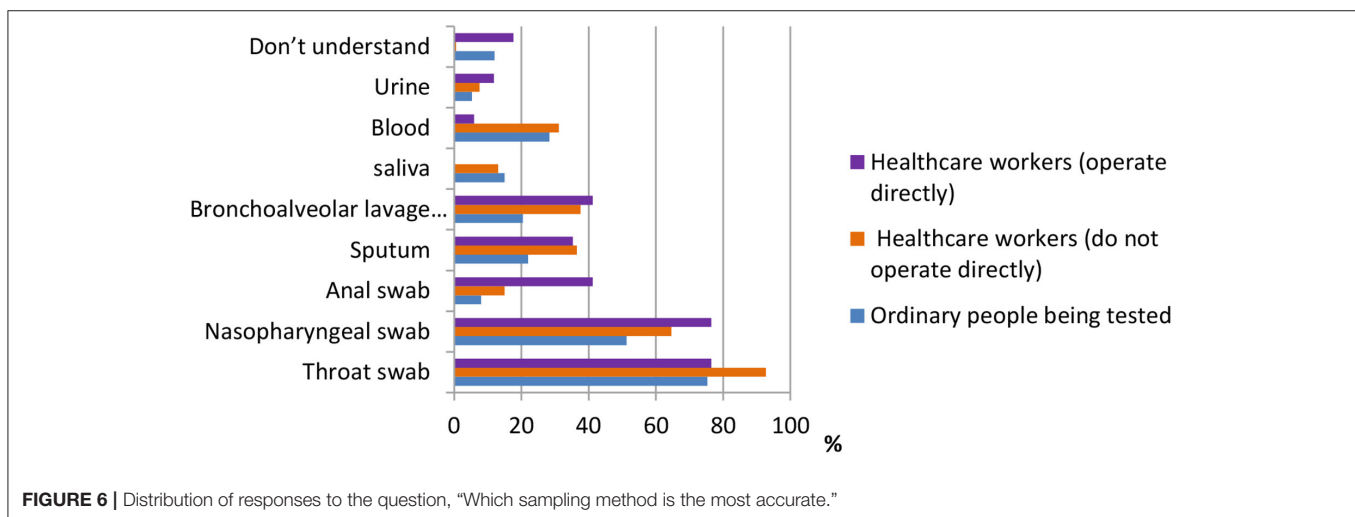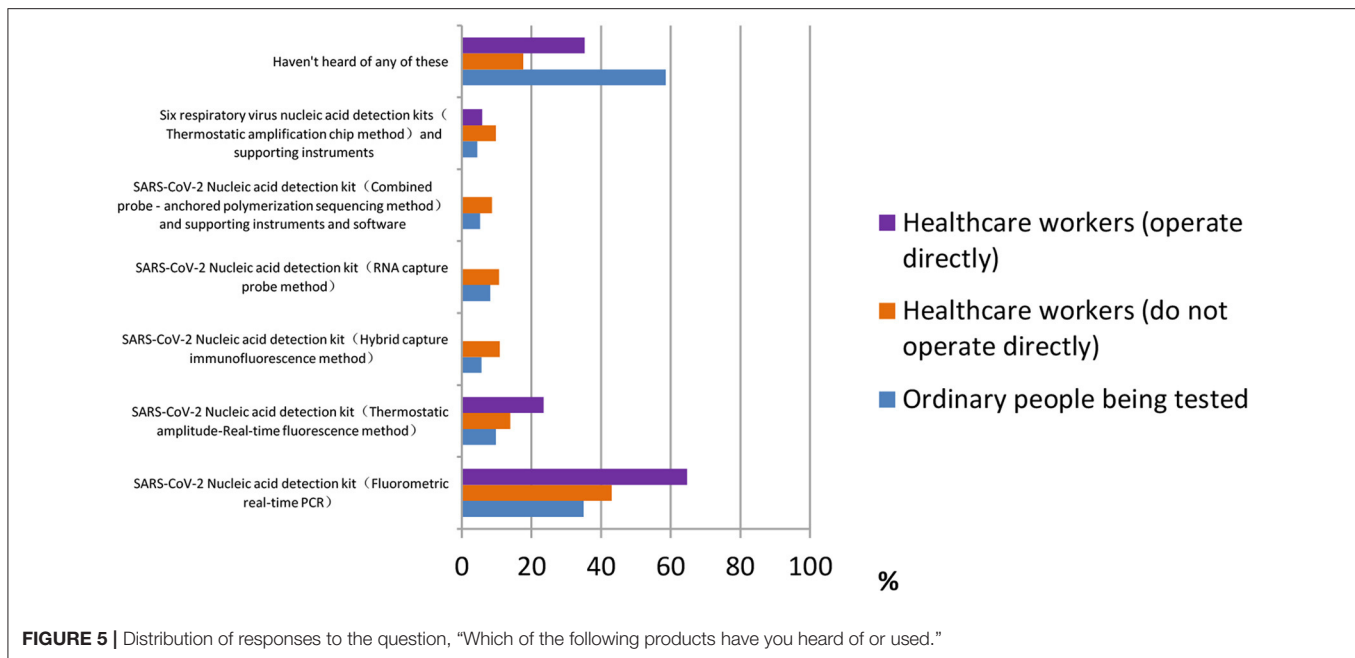
workers who do not operate directly (HW1), and healthcare workers who operate directly (HW2). In the question "How do you identify a suspect of COVID-19?" the majority of the three groups of participants {OP [512 (79.6%)], HW1 [450 (96.6%)], and HW2 [13 (76.5%)]) believed that "The COVID-19 nucleic acid, antigen, and antibody tests were positive" was the right answer. In the question "Which means of COVID-19 detection have you heard of during this pandemic?" the nucleic acid test was the detection method most heard among three groups {OP [629 (97.8%)], HW1 [455 (97.6%)], and HW2 [17 (100%)]}, whereas the antigen test {HW1 [163 (35.0%)], HW2 [3 (17.6%)]} and the antibody test {HW1 [244 (52.4%)], HW2 [11 (64.7%)]} were more often heard among healthcare workers, according to **Figure 2**.

According to the data shown in **Figures 3**, **4**, three groups of participants had different answers on the accuracy rate of the

nucleic acid test, the antigen test, and the antibody test. From the data, we observed that most ordinary people being tested do not understand the accuracy rate of nucleic acid test and antigen/antibody test. Only 33.3 and 46.8% do. On the other hand, more percentage of healthcare workers who do not operate directly [178 (38.2%), 165 (35.4%)] chose "above 90%" in both nucleic acid test and antigen/antibody test, whereas most of the healthcare workers who operate directly chose the answer "60–90%" in both questions.

For the question "Which of the following products have you heard of or used," most ordinary participants [377 (58.6%)] did not understand any of the products, according to **Figure 5**. Healthcare workers who do not operate directly were most familiar with the SARS-CoV-2 nucleic acid detection kit (fluorometric real-time PCR) [277 (64.7%)]. The majority of healthcare workers who operate directly also chose this answer

Factor	Level
N	1,167
Testing kits are produced both domestically and abroad. Which kind of testing kit do you prefer?	
Those produced domestically	822 (70.4%)
Those produced abroad	81 (6.9%)
I do not care	264 (22.6%)
Do you think the residents being tested should self-pay the testing?	
Yes	115 (9.9%)
No	353 (30.2%)
Partly	667 (57.2%)
It does not matter	32 (2.7%)
Do you think it is necessary to set up detection centers at places where there is high population density, such as airports, bus stations, and ports?	
Yes, it is necessary	706 (60.5%)
No, it is unnecessary	37 (3.2%)
It could be done in accordance with specific public transportation lines	414 (35.5%)
I do not really care	10 (0.9%)
Which one do you think may contribute to the false-positive result?	
(Cross contamination of instruments or reagents)	680 (58.3%)
(Misoperation)	548 (47.0%)
(The person being tested is at a specific stage of disease development)	712 (61.0%)
(Other reasons)	49 (4.2%)
(Do not understand)	205 (17.6%)
What do you think contributes to a false-negative result? (check all that apply)	
The kit's sensitivity is too low	749 (64.2%)
Not enough samples were extracted to produce accurate results	714 (61.2%)
The samples were extracted too soon or too late	477 (40.9%)
The sample was not properly extracted (too high—extracted samples from the oral cavity or too low—extracted samples from the lung)	547 (46.9%)
The tested population used antibiotic drugs prior to the nucleic acid test	372 (31.9%)
Instrumental error	422 (36.2%)
Improper operation	494 (42.3%)
Other reasons	18 (1.5%)
I do not know	181 (15.5%)

[11 (43.1%)]. We learn from the figure that many products are still alien to the public.

One of the most important pieces of information in terms of knowledge of COVID-19 is the sampling method. According to the data shown in **Figure 6**, for ordinary participants, the answers throat swab [484 (75.3%)], nasopharyngeal swab [330 (51.3%)], and blood test [182 (28.3%)] were the most common. For healthcare workers who do not operate directly, the answers throat swab [432 (92.7%)], nasopharyngeal swab [301 (64.6%)],

and bronchoalveolar lavage fluid [175 (37.6%)] were the most common. Finally, for healthcare workers who operate directly, the answers throat swab [13 (76.5%)], nasopharyngeal swab [13 (76.5%)], and bronchoalveolar lavage fluid and anal swab [both 7 (41.2%)] were the most common.

The Attitudes Toward the Use of Testing Kits for SARS-CoV-2

Five questions were designed to investigate attitudes toward the use of SARS-CoV-2 testing kits. The questions are shown in **Table 3**. According to the data shown in **Figure 7**, the majority of ordinary participants [354 (77.8%)] agreed that residents being tested should self-pay for the testing, whereas the majority of healthcare workers [282 (60.5%), 11 (64.7%)] thought that they should only be required to pay part of the testing fee. In addition, the majority of all three groups of participants {OP [358 (55.7%)], HW1 [311 (66.7%)], and HW2 [12 (70.5%)]} agreed that it is necessary to set up detection centers at places with high population densities, such as airports, bus stations, and ports.

False-negative results of COVID-19 detection are still a serious issue all over the world. Many factors may cause a false-negative result. According to the results shown in **Figure 8**, the majority of ordinary people believed "the kit's sensitivity is too low" [388 (60.3%)], followed by "not enough samples were extracted to produce accurate results" [361 (56.1%)] and "the sample was not properly extracted (too high—extracted samples from the oral cavity or too low—extracted samples from the lung)" [250 (38.9%)]. Healthcare workers who operate directly had the same answers as ordinary participants [13 (76.5%), 11 (64.7%), and 9 (53%)]. However, healthcare workers who do not operate directly answered "improper operation" [288 (61.8%)] as the third main reason for causes of false-negative results, whereas the other two were the same as above [329 (70.6%), 326 (70%)].

Different Age Groups in the Knowledge of Testing Kits for SARS-CoV-2

In this section, ordinary people being tested for COVID-19 were selected to observe whether different age groups had different answers regarding their knowledge of SARS-CoV-2 testing kits. Three main population groups were selected, from ages 20 to 30 (344 participants), 31 to 40 (372 participants), and 41 to 50 (293 participants). According to the results shown in **Figure 9**, for the question "how to identify a suspect of COVID-19," the answer "inspection found that the COVID-19 nucleic acid, antigen, and antibody tests were positive" was agreed on by the majority of all age groups [154 (44.8%), 133 (35.8%), and 146 (49.8%)].

In **Figure 10**, the data showed that in the question "which sampling method do you think is the most accurate," both age groups 31–40 and 41–50 agreed that the throat swab was the most accurate method [128 (34.4%), 130 (44.4%)], followed by the nasopharyngeal swab [82 (22.0%), 93 (31.7%)] and the blood test [53 (14.2%), 54 (18.4%)]. On the other hand, the answer of sputum came in third [54 (15.7%)] in the age group 20–30, whereas the first two reasons were the same as the other groups [148 (43.0%), 105 (35.5%)].
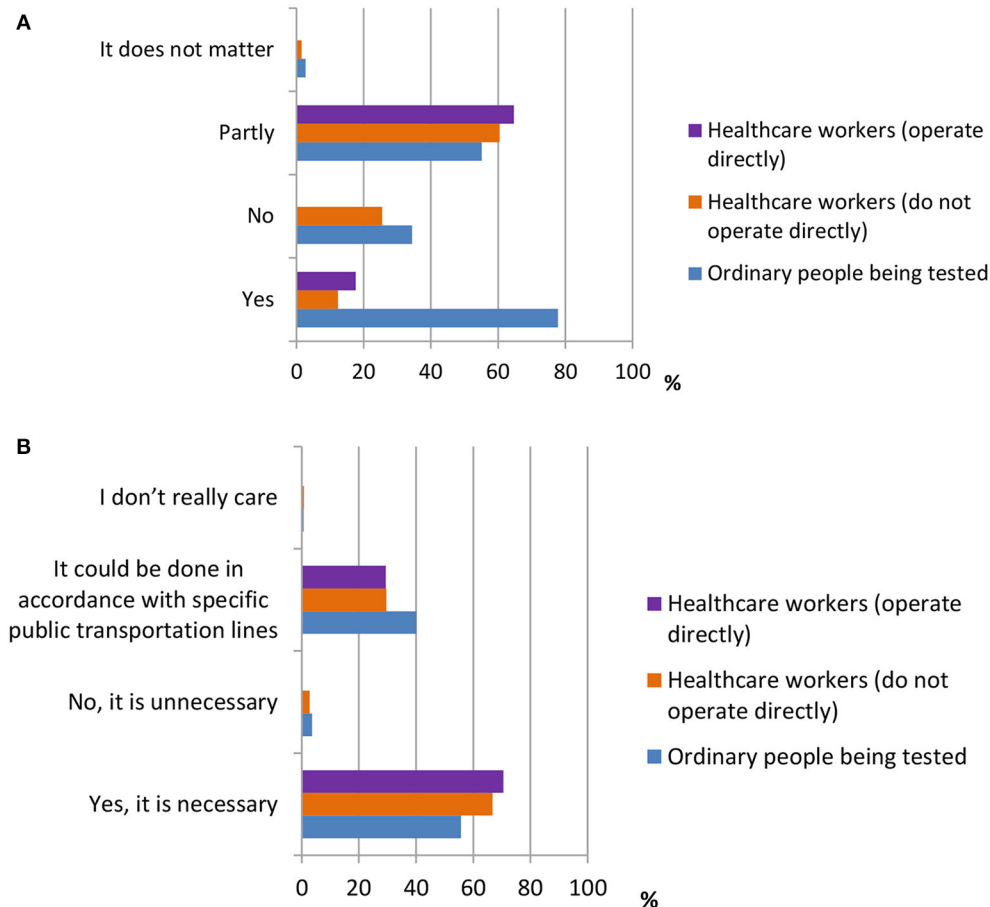
FIGURE 7 | The attitudes towards the use of testing kit for SARS-CoV-2. **(A)** Distribution of responses to the question, "Do you think the residents being tested should self-pay the testing?" **(B)** Distribution of responses to the question, "Do you think it is necessary to set up detection centers at places where there is high population density."
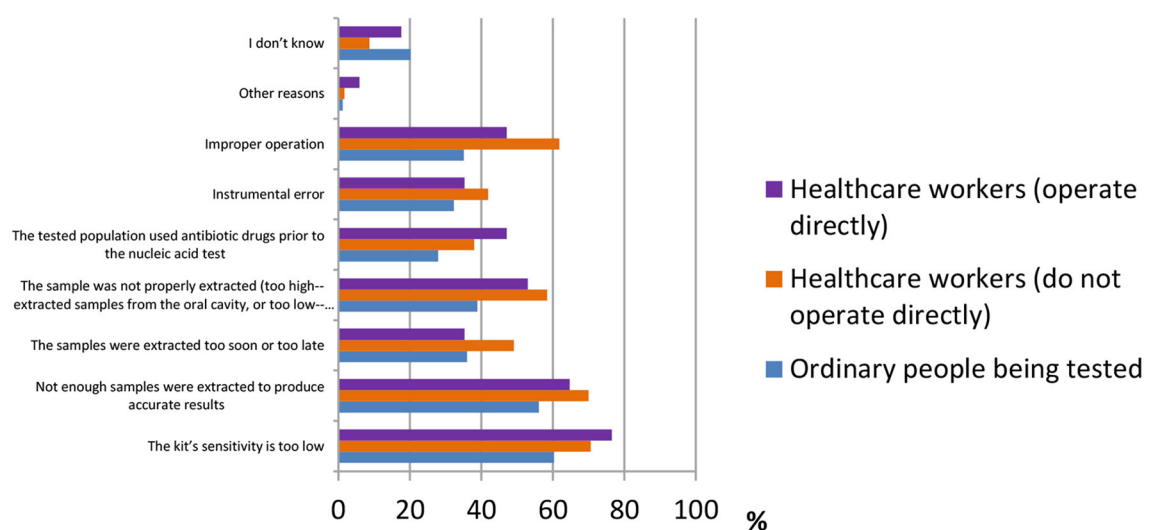
FIGURE 8 | Distribution of responses to the question, "Causes of false-negative results."

FIGURE 9 | Knowledge of testing kit for SARS-Co V-2 in different age groups.

FIGURE 10 | Distribution of responses to the question, "Which sampling method is the most accurate" in different age group.
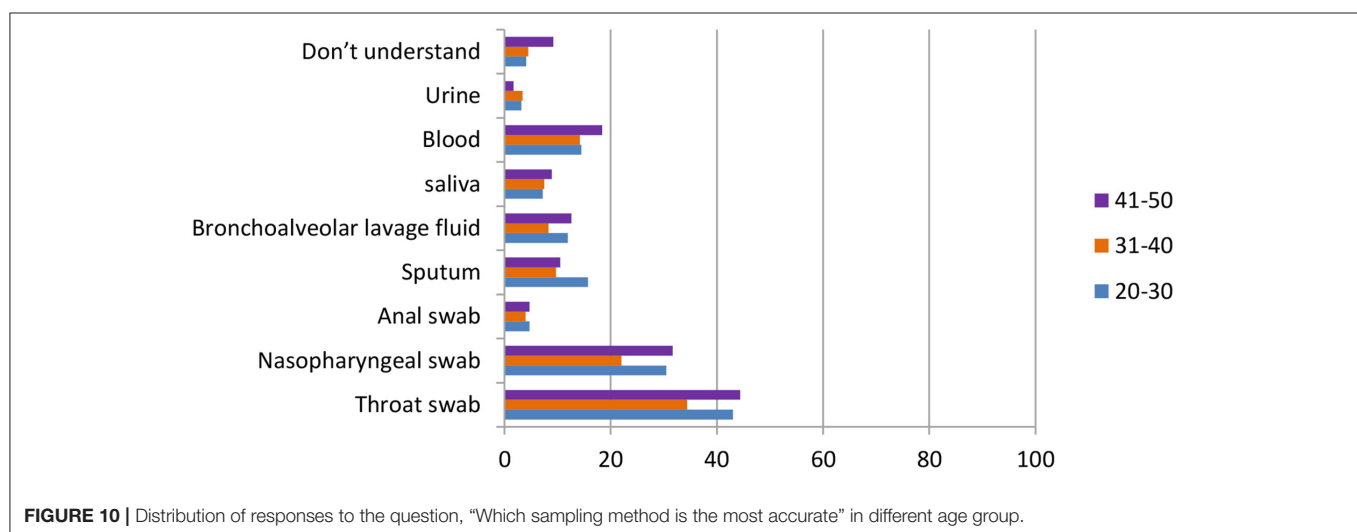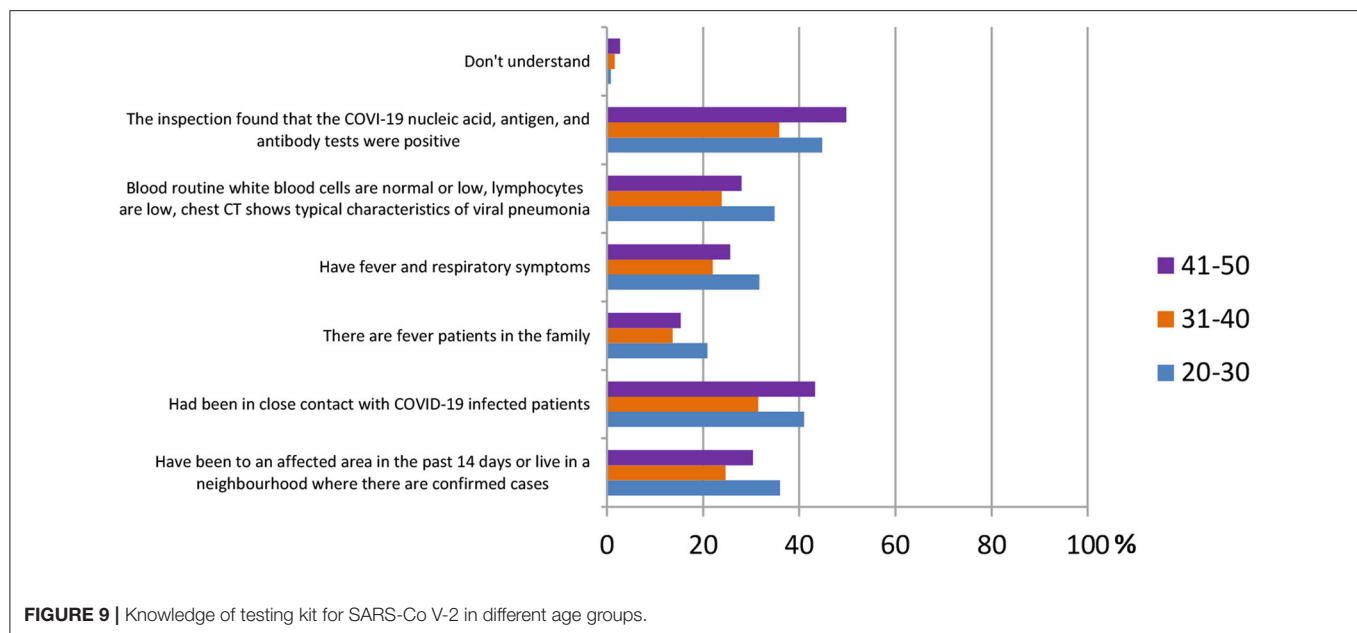
The Likert Scale of Attitude Toward the Use of the SARS-CoV-2 Testing Kit

In this section, the Likert scale was used to assess the attitude toward the use of the SARS-CoV-2 testing kit, and four questions were designed. According to the results shown in **Table 4**, we can observe that more people agreed it is a good thing that China has issued the emergency approval policy for novel coronavirus testing products (6.16 ± 1.30) as well as investing more in scientific research and biomedicine to improve the accuracy of detection kits (5.94 ± 1.55). Some participants also agreed that companies can sacrifice the detection time to increase detection accuracy (4.66 ± 2.00), whereas fewer participants agreed that in the development process of the detection kit, detection accuracy can be sacrificed to speed up detection (3.02 ± 2.04).

DISCUSSION

The present study mainly investigated the public's knowledge and confidence in the SARS-CoV-2 detection kit. The results revealed that apart from those who were directly involved in the use of the detection kit, the public has great basic knowledge regarding the detection methods of the SARS-CoV-2 virus and the types of test kits, as well as great confidence in China in the domestic production of test kits and policy-making.

Up to now, a variety of detection methods have been available, such as RT-PCR, isothermal amplification assays, antigen, imaging, serology, neutralizing vs. binding antibodies, and so on; among them, the nucleic acid test, antigen test, and antibody test are the most recognized among the public. Results showed that the nucleic acid test remained the most common

TABLE 4 | The Likert scale of the attitude of the use of testing kit for SARS-CoV-2.

Factor	Value
N	1,167
Some people think that China needs to invest more in scientific research and biomedicine in order to improve the detection accuracy of testing kits. Do you agree with this opinion? mean (SD)	5.94 (1.55)
Some people think that it is a good thing that China has introduced the emergency approval policy for COVID-19 detection products. Do you agree with that? mean (SD)	6.16 (1.30)
Some people think that the detection time can be sacrificed in the development of detection kit to increase the detection accuracy. Do you agree with this opinion? mean (SD)	4.66 (2.00)
Some people think that detection accuracy can be sacrificed in the development process of detection kit, so as to accelerate the detection speed. Do you agree with this opinion? mean (SD)	3.02 (2.04)

COVID-19 detection method that people have heard of, and that it is also the preferable test method. There are several kinds of nucleic acid test methods, namely PCR-based methods, regular loop-mediated isothermal amplification (LAMP)-based methods, sequence-specific LAMP-based methods, rolling circle amplification-based methods, and microarray-based methods (27). The virus nucleic acid RT-PCR test has become the current standard for the diagnosis of COVID-19. PCR is widely used for virus identification with high sensitivity and specificity (27), yet these RT-PCR test kits suffer from many limitations. For example, they have long turnaround times and are complicated in operation, averaging over 2–3 h to generate results. Besides, the PCR tests require certified laboratories, expensive equipment, and trained technicians to operate (8). There is also the risk of false-negative results. Despite the PCR, the LAMP assay is rapid and does not require expensive reagents or instruments. Therefore, the LAMP test might help reduce the cost of detecting coronavirus. Meanwhile, LAMP shows optimal performance at around 65°C, which always limits its applications and is therefore hard to operate. Rolling circle amplification has the main advantage in that it can be performed under isothermal conditions with minimal reagents and can avoid the generation of false-positive results, which is frequently encountered in PCR-based assays. The microarray assay is a detection method with rapid and high throughput. Due to its superiority, the microarray assay has been widely used in the detection of coronavirus (28).

In addition, only a few people have knowledge about antibody tests. Testing of specific antibodies of SARS-CoV-2 in patient blood is suitable for rapid, simple, highly sensitive diagnosis of COVID-19. Compared with RT-PCR, it saves time, and it does not require equipment; it is simple to perform and only requires minimal training. It will be more convenient to use fingerstick blood or heel blood instead of vein blood for out of clinic screening. However, this test cannot confirm virus presence, which only provides evidence of recent infection; it also has the risk of false-positive and false-negative results. Therefore, the

combination of nucleic acid RT-PCR and the IgM–IgG antibody test can provide more accurate results (29).

The last one is the lesser-known antigen test. Coris COVID-19 Antigen Respi-Strip test (30) is a dipstick immunochromatographic test designed to detect SARS-CoV-2 antigen in nasopharyngeal secretions within 15 min. Although it has several advantages, such as the ease and fast achievement of the test, the rapid answer, the lower cost, and the non-requirement of special equipment or skills compared with molecular techniques, studies suggested that this rapid test is suffering from poor sensitivity and it is not suitable to use alone as the frontline testing for COVID-19 diagnosis (30).

Among all the testing methods, the majority of participants think that throat swab and nasopharyngeal swab are more accurate. Studies have shown that the positive rate of SARS-CoV-2 nucleic acid in sputum is higher than that of nasopharyngeal swabs. Viral nucleic acids were also detected in the blood and digestive tract (fecal/anal swabs). Simple detection of nasopharyngeal swab SARS-CoV-2 nucleic acid detection positive rate is not high, and multi-sample SARS-CoV-2 nucleic acid detection can improve the accuracy, reduce the false-negative rate, better guide clinical treatment, and evaluate the therapeutic effect (31). Saliva also plays an important role in testing; it has many benefits as a diagnostic fluid as it is easy to collect and store and contains extremely good quality DNA (32).

Although there are many detection methods for COVID-19, getting a false positive or false-negative result is still a huge issue during detection. False-negative testing of NP RT-PCR for SARS-CoV-2 is a clinically relevant problem with multiple important implications, especially in pregnant women with suspicion of severe and/or critical COVID-19 (33). There were many kinds of specimens collected from one patient, but always, only one specimen type was detected for the presence of SARS-CoV-2, which indicated that the specimen used for nucleic acid test should be collected from multiple body parts before discharge (34). Therefore, to lower the false-positive or false-negative rate, infection control measures, such as physical distancing, hand hygiene, environmental cleaning and disinfection, and adequate PPE for healthcare workers, should be strictly adhered to in order to develop and disseminate accurate diagnostic tests, assess risk levels before testing, and establish risk-stratified protocols for management of negative COVID-19 test results (34).

Nowadays, many countries produce a large number of COVID-19 test kits; a large proportion of the population, in fact, have been tested. The number of test kits should soon meet the demand. However, that alone will not solve the enormous coronavirus testing backlog (35). Having test kits will not complete the whole process of SARS-CoV-2 detection because a test is not a single device. COVID-19 testing involves several steps, each one requiring different supplies, and there are shortages at various phases of the process at different times and in different places. The healthcare labor force in some countries is not enough to meet the demand for COVID-19 virus detection, so even if these countries have enough test kits, it cannot solve the problem.

Since the COVID-19 pandemic is ongoing, there is still a continuing demand for test kits. The robust spread of the disease

across the world has alarmed healthcare workers. Medical device manufacturers have increased the development and production of COVID-19 detection kits (36). Therefore, medical device manufacturers can earn a large amount of profit. The market size for COVID-19 detection kits was valued at USD 3.3 billion till now in 2020 and is expected to witness 17.3% compound annual growth rate (CAGR) from 2020 to 2026 (36). Studies showed that the oropharyngeal swab is expected to account for around USD 920 million in market value in 2020 (36). The immunoassay test strips/cassettes segment is anticipated to account for nearly USD 141 million market value in 2020, owing to the growing demand for rapid test avenues. Besides, studies showed that the diagnostic centers' segment accounted for around 32% market share in 2020 (36). These phenomena may produce problems, such as poor qualities of COVID-19 test kits and long wait times for results, and the detection process may not be vigorously pursued since manufacturers and diagnostic centers may want to earn more profit from it.

In general, most participants have basic knowledge of COVID-19 test kits. Through this study, we observed that the majority of participants have basic knowledge of COVID-19 detection, whereas healthcare workers had even higher knowledge. Since March 2020, the foreign epidemic has spread rapidly in developed countries, such as Europe and the United States. According to the WHO situation report, up to July 30, 2020, 16,812,755 cases are reported, and 662,095 death cases are recorded. Recently, the epidemic situation in third world countries, such as South America and Africa, has become more and more serious, and places, such as Hong Kong SAR, which had calmed the situation before, are now suffering a new wave of virus spread. At the same time, it has exposed the problem of an insufficient supply of COVID-19 test kits. In addition, the supply chain of ingredients for testing has been stretched to its limit, particularly for the materials used to take the virus's genetic material from the sample (37). Due to economic, labor, and production costs or other issues, the testing capacity has been delayed in some countries as well. Moreover, although there are new types of COVID-19 tests that can give more rapid results (in about 15–30 min), there is still a risk of having false-negative results. Plus, since the rapid tests use the same type of nasal swab, they would be subject to errors of sample collection, timing, and degradation (38).

CONCLUSION

In this study, the survey found that the majority of participants have basic knowledge of SARS-CoV-2 virus detection methods.

Most of the participants were able to identify the correct method of COVID-19 detection and the types of virus test kits. They also have great confidence in Chinese domestic production of test kits and the corresponding policy-making. All participants, including ordinary people and healthcare workers, had enough test kits and detection method information. Up until now, many countries, including the United States and Brazil, are still suffering from high rates of COVID-19. Even in China, sporadic cases still appear from time to time. Obviously, having enough knowledge about SARS-CoV-2 virus detection will benefit society during this pandemic. However, easing anxiety about the pandemic does not depend only on great knowledge of virus detection methods, and whether high compliance rates and knowledge of SARS-CoV-2 virus detection methods contribute to the pandemic problem remains unknown.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/supplementary materials, further inquiries can be directed to the corresponding author/s.

ETHICS STATEMENT

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

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Health Professionals of Prevention in Italy: The Value of Expertise During COVID-19 Pandemic

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There are 22 different degree courses related to the Healthcare Professions in the Italian university system, which are divided into four areas. "Healthcare Professions of Prevention" is the fourth area and it is fundamental for the National Health Service. In particular, in this pandemic emergency situation, the contribution of the Prevention Technicians in the Environment and Workplaces (PTEW) is essential in the field and workplace management. The "Core Competence" of the PTEW is to carry out, with professional autonomy, prevention, verification, and control activities in the field of hygiene and safety of living and working environments. In the hospitals, the indications provided by national and/or regional authorities are implemented through procedures on good hygiene practices developed by PTEW (e.g., hand hygiene, "respiratory tract hygiene," environmental hygiene, social distancing, and use of Personal Protective Equipment). One of the activities is the health surveillance on the field by population monitoring. The protocols foreseen for the "in-flow of workers" involve a wider control between social life and work. The PTEW will use a Check List divided into 3 macro phases: Entry, Activity Context, and Exit, defining each behavior of the work phases with a constant presence of verification of the procedures. The PTEW will be a Leader on the topics of education, training, and persuasion, considering a New Principle that "*transforms the worker as active part in the application and diffusion of the safety measures*".

Keywords: prevention, COVID-19, occupational health, public health, health care professions

In the Italian university system the bachelor's degree related to the Health Professions is included uniquely in the Faculty of Medicine and Surgery. There are 22 different degree programmes that are divided into four areas of Health Professions[1]: Nursing and Obstetrics, Rehabilitation, Technicians and Prevention.

The common objective of these 22 courses is the health and the preservation of the population; this is particularly true if a study programme that involves a direct contact with the patient is chosen, but also taking into account the value of the Global Public Health[2,3].

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[1] Decreto 3 novembre 1999, n.509 Regolamento recante norme concernenti l'autonomia didattica degli atenei.

[2] D.M. 19 febbraio 2009 Determinazione delle classi dei corsi di laurea per le professioni sanitarie, ai sensi del Decreto Ministeriale 22 ottobre 2004, n. 270.

[3] Decreto 22 ottobre 2004, n.270 Modifiche al regolamento recante norme concernenti l'autonomia didattica degli atenei, approvato con decreto del Ministro dell'università e della ricerca scientifica e tecnologica 3 novembre 1999, n. 509.

The Nursing and Obstetrics Health Professions involve a direct contact with patient. The Nurses are responsible for general nursing care and their main skills are disease prevention and care of patient. The midwives assist women during pregnancy, childbirth and puerperium, carry out deliveries and care for the newborn.

The area of the Rehabilitation Health Professions, which includes eight degree courses, aims to train highly specialized professionals in health rehabilitation, for example Physiotherapists, Speech Therapists, and Occupational Therapist, each with specific skills for the rehabilitation of the patient.

The area of Healthcare Technical Professions includes nine degree courses and trains technical figures specialized in different fields. These technicians work in two different areas, the technical-diagnostic area (Laboratory Technicians) and the technical-assistance area (Dental Hygienists) enabled to use technical procedures necessary to perform disease diagnosis on biological materials or on the person.

The Health Care Professions of Prevention includes two degree courses to train professionals able to use prevention methodologies for the community or the individual health: Health Assistants (HA) and Prevention technicians in the environment and in the workplace (PTEW). In particular, the PTEW carry out, with professional autonomy, prevention, verification, and control activities in the field of environmental hygiene and safety in the workplace, food and beverage hygiene, public and veterinary health and hygiene[4].

PROJECT/PROGRAM METHODS

The "Core Competence" of the PTEW cover the activities that identify professional practice and "distinguish" it from other professions. Two essential elements explain the specificity of PTEW and are synergistic by enhancing this professional figure. The first element concerns the health specificity of the profile given by the professional mission that represents the guarantee of the citizen's health objectives. The second element is given by the wide exercise of the professional expertise that in an almost exclusive way, can be performed by the PTEW in the previously mentioned contexts. The definition and the regulations recognize the PTEW as a "health professional" who can practice both within the Public Prevention Departments and as a freelance profession[5].

During this pandemic COVID-19 emergency in Italy, the contribution of the PTEW is fundamental hospital, territorial, and workplace management.

In the hospitals, the indications provided by national and/or regional authorities are implemented through procedures drawn up by PTEWs. Health and hygiene recommendations are implemented through education, training, promotion, and monitoring of good hygiene practices and field testing[6] For example, through the promotion of hand hygiene, the promotion of adequate "respiratory hygiene," environmental hygiene, social distancing and the use of appropriate Personal Protective Equipment (PPE). All workplaces represent, in fact, an important opportunity to spread the activity of sensitization on the correct behavior to be kept to reduce the transmission of the virus and the risk of contagion.

Regarding the Occupational Health in hospitals, the preventive measures to reduce the risk of infection in a workplace with COVID-19 disease are similar to those adopted for the general population. The related risk assessment document in the workplace must be updated in accordance with Legislative Decree no. 81/2008—transposition of EU Directive 89/391/EEC (81/08)[7], which is the basis of Italian legal system in the matter of health and safety at work[8].

The hospital employer has an obligation to provide his employees with correct information about the context in which we work. In according to 81/08, the employer must provide workers with the necessary and adequate PPE, the use of PPE and adequate awareness and training on how to use, dress, undress and disposal, are additional precautions necessary for healthcare workers in order to protect them and prevent the transmission of the virus in health and social environment.

In the COVID-19 situation, it is essential to pursue the objective of maximum possible protection of personnel, equipping them, on the base of evidence, with PPE of an appropriate level for the occupational risk they are exposed to.

In the field, the PTEW can work in multidisciplinary work teams in Prevention Departments within the Public Health Service (PHS), in the fight against the spread of Coronavirus by offering its professional contribution independently.

The health surveillance is implemented by population monitoring through daily contact to keep records of the symptoms attributable to Covid-19; in addition to the surveillance at home, the same activity takes place at the Extended Care, which currently are structures at greater risk of infection with the Coronavirus. The PTEW working in PHS have the task of managing mandatory notifications of infections from local hospitals, useful to epidemiological objectives.

The activities of the PTEW create networks and interconnections with the Stakeholders present on the field with the aim of promoting the Value of Population Health Prevention toward a culture of continuous improvement of the quality of care in terms of Safety and Patient Compliance.

The Coronavirus pandemic has upset and altered our habits by asking the Central Government to immediately introduce the Anti-Infection Protocols, fighting against Biological Risk, within the concept of "prevention."

The Local Health Authorities, through the Prevention Departments, had to activate the new Protocols, for the risk

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[4]Decreto Ministeriale 17 gennaio 1997, n. 58 Regolamento concernente la individuazione della figura e relativo profilo professionale del tecnico della prevenzione nell'ambiente e nei luoghi di lavoro.
[5]LEGGE 11 gennaio 2018, n. 3 Delega al Governo in materia di sperimentazione clinica di medicinali nonche' disposizioni per il riordino delle professioni sanitarie e per la dirigenza sanitaria del Ministero della salute.

[6]Rapporto ISS COVID-19 n. 4/2020 Rev. Indicazioni ad interim per la prevenzione e il controllo dell'infezione da SARS-COV-2 in strutture residenziali sociosanitarie.
[7]Decreto Legislativo 9 aprile 2008n n.81 e s.m.i. Testo unico sulla salute e sicurezza sul lavoro.
[8]Legge 23 dicembre 1978, n. 833, Istituzione del servizio sanitario nazionale.

related to Coronavirus, in every kind of company, facing a risk not specific to their activities and therefore without a training and culture about it.

The PTEW, will have to monitor the evolution of the Coronavirus related Risk without underestimated the other Risks: Chemical (use of sanitizing substances), Stress related work, Education, Training and Interferences (suppliers).

The protocols foreseen for the "in-flow of workers" will have a wider control between social life and work. The PTEW will intervene, in a more incisive way, using a Check List divided into 3 macro-phases: Entry, Context Activities, and Exit, defining each behavior in the different phases and sub-phases of work with a constant verification of the procedures.

The Occupational Safety and Health Administration (OSHA) through the "Guide to the preparation of workplaces for COVID-19" suggests to employers a useful reference for the correct management of the Covid-19 diffusion risk. With reference to the guideline, the HACCP concept could be introduced to analyse the hazards, critical control points (CCP) as used in the food safety[9].

After the hazard analysis, the following CCP can be identified:

CCP1-ENTRY: Health status assessment (temperature), access route (CCP as subject to contamination). The disinfectant products, protective equipment and dressing procedures must be provided in the entrance area.

CCP2–CONTEXT ACTIVITIES: Consider the need to integrate emergency teams and reprogram emergency scenarios, supervise and correct protocols for precautionary measures (worker participation).

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[9]Guidance on Preparing Workplaces for COVID-19 U.S. Department of Labor Occupational Safety and Health Administration OSHA 3990-03 2020.

CCP3-EXIT: In high-risk workplaces (Covid patients) it is useful the use of existing decontamination techniques (e.g., asbestos sites).

DISCUSSION

The company's self-control plan with the support of controllers becomes indispensable in the management of Biological Risk by Covid-19.

The PTEW will be a Leader on Information, Training and Persuasion issues, considering a New Principle that "transforms the worker as active part in the application and diffusion of the safety measures" [1].

In the end "We don't have the luxury of applying urgent public measures to the society we want. We have to apply them to the society we have. That means that public health cannot offer magic bullets, as alluring as superhero status might be" [2].

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

AUTHOR CONTRIBUTIONS

MW, FP, VP, and VC had the idea and contributed to the writing of the text. PL carried out the final revision. All authors contributed to the article and approved the submitted version.

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Nursing Students' Perceptions, Knowledge, and Preventive Behaviors Toward COVID-19: A Multi-University Study

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Background: Knowledge, perception, and preventive behavior should be considered in the planning of effective educational interventions for the coronavirus disease of 2019 (COVID-19) pandemic and in increasing awareness about the health risks brought about by this disease. This research aimed to assess knowledge, perceptions, and preventive behavior toward the COVID-19 infection among student nurses.

Methods: The study has quantitative, descriptive, and cross-sectional design. A convenience sample of 1,226 student nurses from seven universities in Saudi Arabia was surveyed from March 22 to April 4, 2020. A four-part online survey on demographic characteristics, perceptions, knowledge, and preventive behavior of Saudi student nurses was carried out.

Results: Nearly all students were aware of the outbreak (99.2%), and most of them received information on COVID-19 primarily from social media (71.0%). Over three-fourths of the students were confident that the government (89.1%) and Ministry of Health (MOH) (86.5%) were doing a good job responding to the COVID-19 outbreak in the country. The overall average score in the knowledge questionnaire was 9.85 (SD = 1.62, range = 0–12), which is equivalent to 82.1%. The majority of the students always performed most of the preventive behavior identified in the survey, except "washing hands with soap and water for at least 20 s after blowing my nose, coughing, or sneezing" (39.2%) and "daily cleaning and disinfecting frequently touched surfaces" (41.6%). Being female, being in the fourth year, and gaining good perceived knowledge were associated with high actual COVID-19 knowledge. University, gender, age, academic level, and perceived COVID-19 knowledge were the associated factors.

Conclusions: The findings of this study have provided baseline information on the current state of Saudi nursing students' perceptions, knowledge, and preventive behavior

toward COVID-19 as the crisis is happening. The findings revealed some areas that should be focused on by nursing education, as well as health agencies, to ensure that the students have adequate knowledge and correct preventive behavior.

INTRODUCTION

The fight against coronavirus disease of 2019 (COVID-19) remains ongoing in Saudi Arabia and around the world. To date, there are more than 41.5 million confirmed cases globally and more than 340,000 confirmed cases in Saudi Arabia (1). The COVID-19 pandemic has immensely affected all aspects of society (2). At present, a vaccine and medicine against COVID-19 have yet to be developed, and the prevention and control of this disease are the major challenges that every country faces.

Since the outbreak of the disease, different governments around the world have been implementing measures to contain and prevent the transmission of COVID-19. The World Health Organization published COVID-19 guidelines and protocols, which were adopted by the ministries of health of different countries (3). These protocols include information on signs and symptoms and prevention of and protective measures against COVID-19. The Centers for Disease Control and Prevention reiterated that everyone should protect themselves and others to prevent the spread of the disease; such protection includes proper hand hygiene, proper distancing, use of mask, proper etiquette when coughing and sneezing, and isolation and decontamination of surfaces (4). The success of the measures implemented is based on the people's adherence to prevention controls, which is largely influenced by knowledge, perception, and preventive behavior against COVID-19 (5). In the US, 47% of the surveyed population are willing to engage in preventive behavior (e.g., hand hygiene by using soap, water, and disinfectants, such as hand sanitizers) (6). However, adapting these preventive and control behavior requires adequate knowledge, right perception, and positive attitudes, as proposed by the Knowledge–Attitudes–Behavior (KAB) model (7, 8).

The KAB model is a vital health education theoretical model that explains the part of knowledge in behavioral changes and emphasizes that changes in behavior are a product of knowledge and attitudes (7). This model proposes that human health behavior can be modified through three continuous processes of change, namely, gaining of knowledge, formation of beliefs, and development of behavior (8, 9). KAB emphasizes that the knowledge of a person can directly affect attitude and indirectly affect behavior through attitude (8). In the present study, knowledge and information received by student nurses about COVID-19 may affect their attitudes to it, and attitude may affect their behavior or actions. Providing students with health information and knowledge through various sources and means is intended to enhance the health related behavior, attitudes, and practices of student nurses with regard to the prevention and control of COVID-19. However, the negative perception of COVID-19 information and misinformation can lead to poor knowledge and practice behavior (10). Thus, the most essential

method to stop the spread of the COVID-19 pandemic is to develop and adopt appropriate preventive behavior, which can be achieved by becoming well-versed in this disease (11).

However, whether student nurses possess adequate knowledge, positive perceptions, and appropriate preventive behavior in relation to COVID-19 remains unexplored. Being components of the nursing curriculum, preventive measures are no longer new to nursing students, but experiencing a pandemic is new to everyone. Thus, the knowledge, perception, and preventive behavior of nursing students may be affected. This notion has been supported by some studies on previous health crises brought about by infectious diseases, such as the Middle East Respiratory Syndrome (MERS)-Cov. For instance, in the study Choi and Kim, student nurses reported low-risk perception of and poor preventive attitudes toward MERS (12). However, to the best of our knowledge, no research on this issue has been conducted among student nurses in Saudi Arabia. In crises, such as the current one, student nurses' knowledge, perception, and preventive behavior should be considered in the planning of effective educational interventions for COVID-19 and in increasing awareness of the health risks brought about by this disease. Therefore, this research aimed to assess the perceptions, knowledge, and preventive behavior of nursing students toward the COVID-19.

MATERIALS AND METHODS

This quantitative, descriptive, and cross-sectional research surveyed nursing students from seven government universities in Saudi Arabia. University A is situated in the northern region. Universities C–E are in the central area. Universities B, F, and G are in the western region. A convenience sample of 1,226 student nurses who met the following criteria was surveyed in this study: (1) registered in the BSN program during the conduct of the study; (2) sophomores, juniors, seniors, or interns; (3) both sexes; and (4) living as a Saudi national.

An online survey in the Arabic language was used for data collection. The online survey had four parts. Part 1 contained the study information. Part 2 asked for the following information: (1) age, (2) sex, (3) university, (4) year level, (5) awareness of the novel coronavirus outbreak in the country, (6) awareness of infected persons in their immediate society, (7) perceived knowledge of COVID-19, (8) perceived knowledge of the prevention and control of COVID-19, (9) sources of COVID-19 information, (10) learning COVID-19 in any of the nursing courses and activities, (11) family members working in hospitals, (12) confidence on how the government responds to the pandemic, and (13) confidence about how Ministry of Health (MOH) responds to the pandemic.

Part 3 comprises an adapted questionnaire from Zhong et al. (13) that measures the COVID-19 knowledge. The questionnaire was developed based on the "guidelines for clinical and community management of COVID-19 by the National Health Commission" of China. The questionnaire had 12 questions covering three aspects: (a) knowledge of the clinical manifestations (four items), (b) knowledge of the mode of transmission (three items), and (c) knowledge of the prevention and control (five items). The items were answered with "true, false, or I don't know" response options. Correct answers were scored as 1, whereas incorrect answers or "I don't know" answers were scored as 0. We added the correct answers to determine the knowledge of the students. High scores indicated superior COVID-19 knowledge. The questionnaire had good reliability, with Cronbach's alpha of 0.71 (12).

Part 4 included statements pertaining to prevention practices for COVID-19. This part was developed by researchers based on CDC (14). Initially, the questionnaire comprised 14 questions on the recommended steps for protecting oneself and others. A panel of nine experts on infection control and prevention evaluated the content validity of the scale. The panel was composed of (1) five assistant professors in nursing who had PhD with specialization in medical–surgical nursing, (2) two medical doctors who specialize in infectious diseases, and (3) two nurses who work as infection prevention and control nurses in a hospital. Nine items had an item-level content validity index of 1, four items had 0.89, and one had 0.56. The researchers decided to exclude the last item, leaving 13 items for the final scale. The scale-level content validity index of the 13 items was 0.97. The students were asked how often they perform the activities in the past week by selecting from three options: always, sometimes, and never. The responses of the students were coded as 2 for always, 1 for sometimes, and 0 for never. Mean scores were calculated with high means, indicating excellent preventive behaviors. The scale was distributed to 50 Saudi nursing students for pilot testing. The analysis revealed a Cronbach's alpha of 0.976.

This research was reviewed and approved by the Nursing Research Ethical Committee of King Abdulaziz University. The participants were recruited online by each collaborator at their respective universities. An online survey link was forwarded to the students through university e-mails, phone numbers, and social groups, which are common for nursing students in the country. A research information sheet, which contains a brief background of the study, importance of the investigation, objectives of the study, needed participation, rights of the respondents, and voluntary nature of participation, was included in the first part of the online survey. The students were asked to proceed with the online survey if they agree to join. Students who completed the survey were deemed to have agreed to participate in the study. We did not collect identification information from the students to ensure privacy and confidentiality throughout the study. A completed survey was automatically registered online. The data collection was from March 22 to April 4, 2020.

The researchers used SPSS version 22.0 for data analyses. Descriptive statistics were used in analyzing and describing different variables (e.g., demographics, perceptions, knowledge, and preventive behavior). Pearson's product correlation, t-test, and one-way ANOVA were performed for the examination of

TABLE 1 | The demographic characteristic and perceptions related to COVID-19 among the Saudi nursing students (n = 1,226).

Demographic variables and COVID-19 perceptions	Mean (SD)	Range
Age in years	21.62 (2.06)	18–45
University	N	%
University A	165	13.5
University B	242	19.7
University C	170	13.9
University D	156	12.7
University E	201	16.4
University F	90	7.3
University G	202	16.5
Gender		
Male	348	28.4
Female	878	71.6
Year of study		
2nd year	471	38.4
3rd year	310	25.3
4th year	265	21.6
Internship year	180	14.7
Awareness of COVID-19 outbreak		
No	10	0.8
Yes	1,216	99.2
Know people in their community infected with COVID-19		
No	1,136	92.7
Yes, confirmed	45	3.7
Yes, but not yet confirmed	45	3.7
Primary source of COVID-19 information		
Television	81	6.6
Social media	870	71.0
Newspaper	58	4.7
Friends	11	0.9
Relatives working in the medical field	129	10.5
Relatives not working in the medical field	2	0.2
University	75	6.1
Learned about coronavirus in any nursing course		
No	884	72.1
Yes	342	27.9
Family member working in a healthcare facility		
No	553	45.1
Yes	673	54.9
Confidence that government is doing a good job responding to the COVID-19 outbreak		
Not at all confident	15	1.2
Not too confident	22	1.8
Somewhat confident	97	7.9
Very confident	1,092	89.1
Confidence that the Ministry of Health is doing a good job responding to the COVID-19 outbreak		
Not at all confident	13	1.1
Not too confident	29	2.4
Somewhat confident	124	10.1
Very confident	1,060	86.5
	Mean (SD)	Range
Perceived knowledge on COVID-19[a]	7.85 (1.87)	0–10
Perceived knowledge on COVID-19 prevention[a]	8.51 (1.81)	0–10

[a]Possible range of scores = 0–10.

demographic variables associated with the nursing students' COVID-19 knowledge and preventive behavior. Tukey's honestly significant difference (HSD) test was used as *post hoc* analysis when ANOVA revealed significant relationships.

RESULTS

The highest number of respondents was obtained from University B (19.7%), whereas the lowest was obtained from University F (7.3%). The students were 18–45 years old (M = 21.62, SD = 2.06). Over two-thirds (71.6%) of the students were female, and over one-third were sophomores (38.4%). Additionally, 25.3, 21.6, and 14.7% of the students were juniors, seniors, and interns, respectively (**Table 1**).

Perceptions Related to COVID-19

Table 1 shows the students' perception of information on COVID-19. Nearly all students were aware of the COVID-19 outbreak (99.2%). A vast majority of the students did not know any person within their immediate community with a confirmed COVID-19 infection (92.7%). However, 45 students (3.7%) knew someone with a confirmed case in their communities, and another 24 students (3.7%) knew someone with suspected COVID-19 infection in their communities. The majority of the students had received their information on COVID-19 primarily from social media (71.0%), relatives working in the medical field (10.5%), television (6.6%), university (6.1%), newspaper (4.7%), and friends (0.2%). Moreover, the majority of the students

reported that they had not learned of the coronavirus from any of their nursing courses (72.1%) and had a family member working in any healthcare facility (54.9%). Over three-fourths of the students were confident that the government (89.1%) and MOH (86.5%) were doing a good job responding to the COVID-19 outbreak in the country. The mean scores in the perceived knowledge of COVID-19 and perceived knowledge of the prevention of COVID-19 were 7.85 (SD = 1.87) and 8.51 (SD = 1.81), respectively, on a scale of 0–10.

Knowledge of COVID-19 and Associated Factors

The overall average score in the knowledge questionnaire was 9.85 (SD = 1.62, range = 0–12), which is equivalent to 82.1%. For the conceptual subscales, the students received the highest percentage of 87.6% in "prevention and control" (M = 4.38, SD = 0.79, range = 0–5), followed by 81.0% in "clinical presentation" (M = 3.24, SD = 0.84, range = 0–4) and 74.3% in "transmission route" (M = 2.23, SD = 0.73, range = 0–3). **Table 2** indicates that the highest percentage of correct responses was recorded in the statement on isolating someone exposed to COVID-19 for 14 days (98.5%), followed by isolating and treating COVID-19 patients for the prevention of the disease's spread (98.0%), avoiding crowded places for the prevention of the spread (95.5%), transmission of the virus through respiratory droplets (92.0%), common clinical manifestation of COVID-19 (91.6%), and significance of treating the symptoms of the

TABLE 2 | Results of the descriptive analyses on the Saudi nursing students' knowledge regarding COVID-19 (*n* = 1226).

Survey items	Students who answered correctly *n* (%)	Mean score (SD)
Clinical presentation (four items)[a]		3.24 (0.84)
The main clinical symptoms of COVID-19 are fever, fatigue, dry cough, shortness of breath, diarrhea, and myalgia.	1,123 (91.6)	
Unlike the common cold, stuffy nose, runny nose, and sneezing are less common in persons infected with the COVID-19 virus.	857 (69.9)	
There currently is no effective cure for COVID-2019, but early symptomatic and supportive treatment can help most patients recover from the infection.	1,109 (90.5)	
Not all persons with COVID-2019 will develop to severe cases. Only those who are elderly, have chronic illnesses, and are obese are more likely to be severe cases.	878 (71.6)	
Transmission route (three items)[b]		2.23 (0.73)
Eating or contacting wild animals would result in the infection by the COVID-19 virus.	578 (47.1)	
Persons with COVID-2019 cannot infect the virus to others when a fever is not present.	1025 (83.6)	
The COVID-19 virus spreads via respiratory droplets of infected individuals.	1,128 (92.0)	
Prevention and control (five items)[c]		4.38 (0.79)
Ordinary residents can wear general medical masks to prevent the infection by the COVID-19 virus.	694 (56.6)	
It is not necessary for children and young adults to take measures to prevent the infection by the COVID-19 virus.	1,100 (89.7)	
To prevent the infection by COVID-19, individuals should avoid going to crowded places such as train stations and avoid taking public transportations.	1,171 (95.5)	
Isolation and treatment of people who are infected with the COVID-19 virus are effective ways to reduce the spread of the virus.	1,201 (98.0)	
People who have contact with someone infected with the COVID-19 virus should be immediately isolated in a proper place. In general, the observation period is 14 days.	1,208 (98.5)	

[a] *Possible range of scores = 0–4,* [b] *Possible range of scores = 0–3,* [c] *Possible range of scores = 0–5.*

disease in helping patients recover (90.5%). Most students were not knowledgeable about that possibility that eating or being in contact with wild animals can cause infection (% of correct response = 47.1%).

Pearson's correlations revealed positive correlations between COVID-19 knowledge and perceived knowledge of COVID-19 ($r = 0.23$, $p < 0.001$) and perceived knowledge on COVID-19 prevention ($r = 0.27$, $p < 0.001$). One-way ANOVA showed significant differences on COVID-19 knowledge in terms of university ($F = 6.19$, $p < 0.001$) and academic levels ($F = 4.01$, $p = 0.008$). Students from Universities B and G had a higher level of knowledge than students from Universities D and E. Senior students scored significantly higher than sophomores ($p < 0.001$) and juniors ($p = 0.037$). Female participants scored higher than male participants ($t = -3.09$, $p = 0.002$; **Table 3**).

COVID-19 Preventive Behavior and Associated Factors

The majority of the students performed 11 of the 13 preventive practices identified in the survey. Following the rules set by the government received the highest percentage of the "always" response (77.4%), followed by "throwing used tissues in trash cans" (75.4%), "avoiding close contact with sick people" (72.6%), "washing hands with soap and water for a minimum of 20 s after going to a public place" (72.3%), and "covering the mouth and nose with tissue when coughing or sneezing or using the inside of the elbow" (70.1%). Two preventive practices, namely, "washing hands with soap and water for at least 20 s after blowing my nose, coughing, or sneezing" (39.2%) and "daily cleaning and disinfecting frequently touched surfaces" (41.6%) were not always performed by the majority of the respondents (**Table 4**).

As shown in **Table 5**, one-way ANOVA revealed significant differences among preventive of the students when grouped according to university ($F = 2.30$, $p = 0.033$) and year of study ($F = 5.40$, $p = 0.001$). Students from University G and students in the internship year had better preventive behavior than students from University A ($p < 0.05$) and sophomores ($p < 0.01$), respectively. Female students (M = 18.96, SD = 8.49) had better preventive behavior than male students (M = 17.55, SD = 9.37, $t = -2.43$, $p = 0.016$). Weak positive correlations existed between preventive behavior scores and age ($r = 0.09$, $p = 0.002$) and between preventive behavior scores and perceived knowledge of COVID-19 ($r = 0.08$, $p = 0.010$).

DISCUSSIONS

Our study focused on assessing the Saudi nursing students' perceptions, knowledge, and preventive behavior toward COVID-19. The findings of our study indicated that students primarily use social media to gather information on COVID-19, using various information sources, such as government agencies, the media, friends, and family (12). The current study's result is similar to that of Huynh and Nguyen (15), who reported that social media is the foremost source of COVID-19 information among healthcare workers in Vietnam. Another study reported that healthcare workers' sources for reliable information on

TABLE 3 | Results of the tests of associations between the Saudi nursing students' COVID-19 knowledge and demographic variables and perceptions related to COVID-19 ($n = 1,226$).

Demographic variables and perceptions related to COVID-19	Saudi nursing students' COVID-19 knowledge		Statistical test	p
	Mean	**SD**		
Age in years			$r = 0.05$	0.074
University[a]				
University A	9.82	1.53	$F = 6.19$	<0.001***
University B	10.18	1.51		
University C	9.84	1.34		
University D	9.33	1.99		
University E	9.65	1.75		
University F	9.71	1.55		
University G	10.13	1.47		
Gender				
Male	9.62	1.63	$t = -3.09$	0.002**
Female	9.94	1.60		
Year of study[b]				
2nd year	9.67	1.72	$F = 5.67$	0.001**
3rd year	9.81	1.71		
4th year	10.17	1.28		
Internship year	9.89	1.55		
Learned about coronavirus in any nursing course				
No	9.89	1.63	$t = 1.78$	0.139
Yes	9.74	1.58		
Family member working in a healthcare facility				
No	9.86	1.67	$t = 0.21$	0.837
Yes	9.84	1.57		
Perceived knowledge on COVID-19			$r = 0.23$	<0.001***
Perceived knowledge on COVID-19 prevention			$r = 0.27$	<0.001***

[a] University B > Universities D ($p < 0.001$) and E ($p = 0.008$), University G > Universities D ($p < 0.001$) and E ($p = 0.037$); [b] 4th year > 2nd year ($p < 0.001$) and 3rd year ($p = 0.037$).
*Significant at 0.05, **Significant at 0.01, ***Significant at 0.001.

COVID-19 are official government websites and social media (16). College students in Hong Kong held the highest level of trust toward health-related evidence provided on social media (17). On practical implication, the use of social media influences students' knowledge of the infection, such as the number of local and international incidents and knowledge of preventive measures. However, students should be responsible and focus on factual information they see on social media. This finding implies the need for nursing education to develop programs, such as educational and awareness campaigns aimed at guiding students to reliable student-centered sources of information about COVID-19. Nurse educators should assist students in selecting the right sources of information, provide student-centered resources, and correct misinformation. Additionally, this finding may help in modifying the contents of some courses (e.g., Infection Control in Nursing and Nursing Informatics)

TABLE 4 | Results of the descriptive analyses on the Saudi nursing students' preventive behaviors (n = 1,226).

Items in the preventive behavior questionnaire	Never n (%)	Sometimes n (%)	Always n (%)	Mean (SD)
1. I wash my hands with soap and water for at least 20 seconds after I have been in a public place	207 (16.9)	132 (10.8)	887 (72.3)	1.55 (0.76)
2. I wash my hands with soap and water for at least 20 second after blowing my nose, coughing, or sneezing	260 (21.2)	486 (39.6)	480 (39.2)	1.18 (0.76)
3. If soap and water are not readily available, I use a hand sanitizer that contains at least 60% alcohol	251 (20.5)	254 (20.7)	721 (58.8)	1.38 (0.80)
4. I avoid touching my eyes, nose and mouth with unwashed hands	241 (19.7)	301 (24.6)	684 (55.8)	1.36 (0.79)
5. I avoid close contact with people who are sick	232 (18.9)	104 (8.5)	890 (72.6)	1.54 (0.79)
6. I put distance between myself and other people	225 (18.4)	269 (21.9)	732 (59.7)	1.41 (0.78)
7. I stay at home if I'm sick, except to get medical care	213 (17.4)	186 (15.2)	827 (67.5)	1.50 (0.77)
8. I cover my mouth and nose with a tissue when I cough or sneeze or use the inside of my elbow	225 (18.4)	141 (11.5)	860 (70.1)	1.52 (0.79)
9. I throw used tissues in the trash	227 (18.5)	75 (6.1)	924 (75.4)	1.57 (0.78)
10. I wear facemask if I am sick	287 (23.4)	237 (19.3)	702 (57.3)	1.34 (0.83)
11. I clean and disinfect frequently touched surfaces daily	291 (23.7)	425 (34.7)	510 (41.6)	1.18 (0.79)
12. I clean surfaces that are dirty	248 (20.2)	200 (16.3)	778 (63.5)	1.43 (0.81)
13. I follow the rules implemented by the government during this COVID-19 outbreak	221 (18.0)	56 (4.6)	949 (77.4)	1.59 (0.78)

and enhance the means for acquiring dependable sources of information related to COVID-19. Future studies should focus on examining ways on how educators can assist students in carefully evaluating their sources of information.

Furthermore, the students were confident that the government and MOH are doing a good job in responding to the outbreak. The result of this study conforms with the result of the study conducted in China, where most of the respondents had positive attitudes toward the COVID-19 pandemic; that is, 90.8% thought that COVID-19 would be effectively controlled, and 97.1% were confident that China can overcome this outbreak (13). Saudi Arabia's MOH implemented several measures and guidelines designed for infection prevention and control, treatment, and public health considerations; healthcare workers were instructed to adhere to these measures strictly. The government of the country had implemented measures to safeguard the health of its citizens and residents and protect them from the disease. These measures aimed to mitigate the spread of the virus within the country (18). The residents of the majority of the regions in the kingdom were not allowed to leave their respective regions or move to another region, local and international flights were canceled, and curfew hours were strictly implemented. People believed that these strict preventive implementations can prevent and control the outbreak. Therefore, nursing education can play a role in disseminating information about the policies and protocols being implemented by the government to ensure their full awareness and compliance. In general, the information dissemination resources of universities, such as their social media accounts and university emails, can be utilized in communicating the government's efforts, guidelines, and protocols to the students.

Our findings revealed a good level of knowledge of COVID-19 among Saudi nursing students. The reported knowledge was slightly lower than the knowledge score reported among residents in China (13) and slightly higher than the score reported among US residents using the same questionnaire (19). The students' good knowledge of the disease revealed in our result may

have been a result of the measures of the government, MOH, and Ministry of Education for improving the awareness of the residents on COVID-19 through information dissemination via social media and news outlets. The Ministry of Education had implemented measures to incorporate COVID-19-related topics in universities to ensure the adequate knowledge of university students. The effectiveness of such effort can be supported by our previous findings, which showed that the students had high confidence in the effort of the government and MOH in addressing the crisis and students highly rely on social media for COVID-19-related information. Our findings showed that students had the highest knowledge in the prevention and control aspect of COVID-19 and the lowest level of knowledge with regard to the transmission route, thereby corroborating the studies conducted in China (13) and US (19). This result can be attributed to the previous experience of Saudi Arabia with the MERS-Cov outbreak, which has similarities with the current pandemic in terms of preventive measures (20).

The level of COVID-19 knowledge among nursing students appeared to vary across different universities. Although each university has exerted efforts to increase the awareness of students of COVID-19, the strategies and frequencies of their educational campaigns may vary. For example, University B had successfully utilized the social media as an effective tool of information dissemination, raising the awareness about COVID-19 among its students (20). The university had implemented a framework for the use of social media to ensure the sustainable management of higher education during the pandemic (21). The university also developed and adopted a curriculum and training program that solely tackles information about the COVID-19 pandemic, preventive measures, and the significance of public health and research in managing the crisis (22). However, the survey was conducted after the government closed all schools, and this situation may have interfered with the information dissemination efforts of some universities. Differences in infection prevention knowledge and practices among Saudi students were also observed in previous studies,

TABLE 5 | Results of the tests of associations between the Saudi nursing students' preventive behavior and demographic variables and COVID-19 knowledge (n = 1,226).

Demographic variables and COVID-19 knowledge	Saudi nursing students' preventive behavior against COVID-19		Statistical test	p
	Mean	SD		
Age in years			r = 0.09	0.002**
University[a]				
University A	17.38	9.46	F = 2.30	0.033*
University B	17.73	9.06		
University C	18.94	8.39		
University D	19.38	7.98		
University E	18.47	9.24		
University F	17.64	9.03		
University G	20.06	7.92		
Gender				
Male	17.55	9.37	t = −2.43	0.016*
Female	18.96	8.49		
Year of study[b]				
2nd year	17.55	8.95	F = 5.40	0.001**
3rd year	18.49	8.93		
4th year	19.12	8.77		
Internship year	20.49	7.61		
Learned about coronavirus in any nursing course				
No	18.72	8.58	t = 1.01	0.311
Yes	18.14	9.24		
Family member working in a healthcare facility				
No	18.48	8.66	t = −0.29	0.771
Yes	18.63	8.87		
Perceived knowledge on COVID-19			r = 0.08	0.010*
Perceived knowledge on COVID-19 prevention			r = 0.02	0.556
COVID-19 actual knowledge			r = 0.05	0.083

[a]University G > University A (p = 0.050), [b]Internship year > 2nd year (p = 0.001).
*Significant at 0.05, **Significant at 0.01.

which attributed these differences to varying course contents, teaching methodologies, and other curricular activities (23, 24). Moreover, our findings indicated that female students had better knowledge than male students. This difference in COVID-19 knowledge between genders was also observed in China and the US, where female students scored higher than male students (13, 19). Gender differences on knowledge among Saudi nursing students had been documented in infection control prevention measures in previous studies (25, 26). The result also indicated that students' knowledge increased as they go higher in the academic ladder, indicating that senior students had a profound understanding of COVID-19-related information possibly because of their exposure to high-level learning and COVID-19-related information in their theoretical courses and

hospital exposures. Thus, nursing education must ensure that student nurses in all levels have equal access to student-centered COVID-19 resources to prevent gaps on knowledge among students in different year levels. Moreover, no gap between perceived and actual knowledge on COVID-19 was observed in our study. This result was evidenced by the positive correlations between the students' perceived COVID-19 knowledge and their actual knowledge scores. That is, students who rated their knowledge high also received high scores in the actual COVID-19 knowledge survey.

On preventive behavior, among the variables measured, following the rules set by the government related to the COVID-19 crisis was the most observed preventive behavior. This behavior can be associated with the "Sharia law," which refers to the correct Islamic behavior (27). Adherence, cooperation, and respect for the law is common to Saudi nationals, as further reflected by the good response of the students to the call of the government and health authorities to protect themselves and others. Furthermore, Saudi student nurses who abide by the imposed rules of the government regarding the prevention and control of COVID-19 is an indicator of their responsibility to Allah, the government, others, and oneself (27). As part of their responsibility to protect others, the proper disposal of waste, social distancing, hand washing, and proper coughing and sneezing etiquette in public are observed. The emphasis on the concept of infection control in all major nursing courses may have contributed to the good preventive behavior of the student nurses (28). However, the student nurses' low preventive practice of disinfecting surfaces highlighted vagueness among them regarding who is responsible for disinfection. This infection prevention practice received a lower emphasis than the other infection prevention practices, such as hand hygiene and using personal protective equipment during clinical practice. Moreover, the students may have observed during their clinical rotation that the disinfection of surroundings are often delegated to nursing attendants owing to the heavy workloads of staff nurses. These assumptions should be confirmed in future studies.

The preventive behavior of student nurses are linked to the university where they study and the year of study. These observed differences in preventive behavior may have been due to variations in the implementation of training programs of nursing schools in Saudi Arabia. The Saudi Licensing Exam blueprint specifically includes infection control as one of its sections (29). However, the absence of a unified nursing curriculum in the country may have contributed to the differences in preventive behavior among students of different universities (30). Moreover, every nursing school has its own program mission, goals, and learning outcomes, which have an impact on the acquisition and delivery of knowledge and the values, training, attitude, and desired level of competency or performance of student nurses. These differences between universities were also observed in the Saudi nursing student in terms of compliance with standard precautions in a previous study (28). Students on internships had better preventive behavior than those in other year levels, indicating that the practical learning experience in the clinical area of

interns may have facilitated the development of their sense of risk perception. The development of the ability to sense and avoid hazards heightened their preventive behavior as a response to the health treatment of the novel coronavirus. Thus, the need for a unified nursing curriculum framework formulated by appropriate governing institutions, such as the Saudi Commission for Health Specialties and/or the Ministry of Education, is highly recommended.

This study used a convenience sampling method, which may have limited the generalizability of the findings. The cross-sectional nature of this research also hindered the examination of causal relationships between variables. The preventive behavioral patterns were self-reported, which may have been influenced by some social desirability bias. Nonetheless, our study is the first large-scale research that measured these variables in Saudi Arabia. The findings reflected the current perceptions, knowledge, and preventive behavior of nursing students as the COVID-19 crisis develops.

Conclusions

Our study concludes that Saudi student nurses had good perceptions of their COVID-19 knowledge and its prevention, as well as positive perceptions on the government and MOH's effort in responding to the COVID-19 crisis. The students had good actual COVID-19 knowledge and preventive behavior against COVID-19. This study provides a basis for developing an educational campaign aimed at improving nursing students' knowledge of and preventive behavior against COVID-19. Having adequate knowledge and the correct preventive behavior against COVID-19 will ensure that nursing students are prepared to respond in future occurrences of similar public health crises. The findings of this study provide baseline information on the current state of the Saudi nursing students' perceptions, knowledge, and preventive behavior toward COVID-19 as the crisis is happening. The findings revealed some areas that should be focused on by nursing education, as well as MOH and other health agencies, for the purpose of ensuring that the population has adequate knowledge and correct preventive behavior. For example, knowledge of the disease's correct transmission routes should be a focus because this aspect received the lowest knowledge score. Some preventive measures should be emphasized, such as washing of hands after blowing your nose, coughing, or sneezing and the disinfection of surrounding areas, given that they were not frequently observed by the respondents. The findings may also guide the nursing profession with regard to its role in health promotion and disease prevention. Given that the main responsibilities of nurses include promoting health and preventing diseases, the findings may guide the creation of a health education program on COVID-19 for the improvement of

the knowledge of the public, encouragement of their adoption of appropriate preventive behavior against the virus, and mitigation of the spread of the infection. Moreover, MOH and other health agencies can maximize the use of social media as an avenue for knowledge dissemination on COVID-19 because this platform is the primarily identified source of information. Contents shared or disseminated through social media should be checked for accuracy by relevant agencies to avoid misinformation and ensure that only factual information reaches the public.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Nursing Research Ethical Committee of King Abdulaziz University, Saudi Arabia. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

HMA contributed to conceptualization, design, study supervision, acquisition of data, interpretation of data, drafting and revision of the manuscript, approval of the final manuscript, and funding acquisition and agreed to be accountable for all the aspects of the work. NA, EB, and JB contributed equally to conceptualization, design, acquisition of data, data analysis, interpretation of data, drafting and revision of the manuscript, and approval of the final manuscript and agreed to be accountable for all the aspects of the work. HA, FA, RT, AA, HT, and EF contributed equally to the acquisition of data, interpretation of data, revision of the manuscript, and approval of the final version and agreed to be accountable for all the aspects of the work. JC contributed to conceptualization, design, study supervision, acquisition, analysis, interpretation of data, drafting and revision of the manuscript, and approval of the final manuscript and agreed to be accountable for all the aspects of the work. All authors contributed to the article and approved the submitted version.

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Collision of Fundamental Human Rights and the Right to Health Access During the Novel Coronavirus Pandemic

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Introduction: COVID-19 requires governmental measures to protect healthcare system access for people. In this process, the collision of fundamental rights emerges as a crucial challenge for decision-making.

Policy Options and Implications: This policy review analyzes selected articles by the PubMed searcher about extreme measures taken in several countries during precedent pandemics and the current pandemic, and selects hard decisions relating to the exceptional measures taken by judicial departments in Brazil, connecting them to the "collision of fundamental rights and law principles." The collision of rights and principles imposed on decision makers a duty to provide balanced rights, and to adopt the enforcement of some rights prioritization. Ethical concerns were also verified in this field involving rights limitations. During a pandemic, the importance of extreme measures to protect health rights and healthcare systems is instrumental for focused, fast, and correct decision making to avoid loss of life and the collapse of healthcare systems. The main goals of this research are to discuss the implications and guidelines for public health decision making, the indispensable ethical and legal aspects for safeguarding health systems and the lives of people, and the respect of the Justice principle and of fundamental health and dignity rights. We conclude that COVID-19 justifies the prioritization of collective and individual health access rights. Acceptable standards of fundamental rights restrictions are established at the constitutional and international levels and must be enforced by rules and governmental action, to ensure fast and accurate decision making during a pandemic. Freedom rights exercises must be linked to solidarity for the realization of social welfare, for the health rights of all individuals and for health systems to function well during a pandemic.

Actionable Recommendations: All individuals are free and equal, therefore social exclusion is prohibited. Institutions must consider social inequalities when discussing

public health measures and be guided by ethical standards, by law principles, and rules recognized by constitutional and international law for the benefit of all during a health pandemic.

Conclusions: Collective and individual health rights prevail over the collision of rights when facing pandemic occurrences, case by case, in health systems protection, based on the literature, on precedent pandemics and on legitimate Public Health efforts.

Keywords: coronavirus infections, human rights abuses, right to health, court decisions, jurisprudence

INTRODUCTION

"Our rights culture cannot constitute us unless all rights count, and all rights cannot count if all rights are absolute."[1]

COVID-19 (the new coronavirus disease) requires judicial decision-making and public policies for countries to protect public and private health systems and consequently the well-being, and in a prior way, the health rights of their citizens.

Both at legal and ethical levels, it is desirable that decision-making in public health, which is even more important in a pandemic context, respects the *non-derogable* guidelines of fundamental human rights, also constitutional rights, and respects law-guided ethical standards, in a way to better protect the health rights of people, and to also provide the secure maintenance of healthcare systems.

Extreme measures taken by countries and governments are justified in the context of the novel coronavirus infection pandemic by the fact that the disease has a high transmissibility rate and the methods of transmissibility are not completely understood by scientists.

However, there is scientific evidence that asymptomatic transmissions, for example, are possible at the same rate as symptomatic cases transmissibility. On the other hand, some studies suggest that asymptomatic cases could be less infectious and mainly contribute to the generation of new asymptomatic cases, also having an inferior rate of transmissibility if compared to symptomatic patients (1).

This way, it is not completely defined in what frequency and intensity asymptomatic cases contribute to the pandemic dissemination. In addition, COVID-19 has a critically high rate of contagion that can lead to the potential collapse of healthcare systems, especially as there is no effective treatment or vaccine available for the illness.

It is also quite normal for the hospitalization of critically ill patients to last several weeks (**Table 1**). A prolonged stay in an ICU facility creates legal, socio-economic, and political consequences that must be considered by governments in regard to healthcare system management in order to keep healthcare systems functioning during the pandemic, and also to avoid, as much as possible, the occurrence of new infections, in the case of shortage of beds in health institutions.

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TABLE 1 | Median time of admission and hospitalization in ICU of critically ill patients with COVID-19 infections.

Articles	Median time for admission in ICU after symptoms	Median time of hospitalization after admission in ICU
Article (2)	10.5 days	11.5 days or more (survivals)
Article (3)	9 days (survivals) 11 days (non-survivals)	More than 17 days (survivals—at least 3 patients or 5,76% of admitted in ICU)

Source: Table developed by the authors by interpreting articles indicated.
Articles cited: full description on items (2) and (3) of the references section.

In this narrated scenario, the collision of fundamental rights emerges as a significant problem for government and healthcare management due to decision making regarding the need to delimit the extension of the acceptable exercise of freedom rights in times of a pandemic. They also need to consider the urgent need for fundamental human rights protection and the implications of pandemic measures on restricting people's rights related to liberty of movement, liberty of travel, liberty of work and to reopen schools.

In addition, more dense social issues demonstrate the illegal conditions of prison facilities and of confinement camps for migrants during the COVID-19 pandemic, that must be considered by authorities to guarantee the right of health for all and to cope with the spread of the virus.

This complex search for better solutions depends on the factual component of the reality of countries and societies. Besides that, communities and states need to attend to important rights for life, health, and human dignity, which are all surrounded by the urgency of public health prioritization.

There are no absolute rights. There are *prima facie* fundamental rights and there are the definitive exercise standards of each fundamental right, in each situation, that are defined beneath the facts and the legal norms of each situation under the law. All of the fundamental rights must be balanced to achieve the maximum protection for all fundamental rights in the reality of social life conflicts and in constitutional principles collision (4).

Post Second World War, European and Western countries, under directives from the United Nations (UN), built legal systems to face the barbarities committed by modern societies. The rights of life and human dignity were elevated to the top of the hierarchy of fundamental rights in constitutions, followed by the rights of freedom, which are also of extreme importance (5).

POLICY OPTIONS AND IMPLICATIONS

The Discussion of Balancing Rights to Freedom and the Necessary Decision to Prioritize the Fundamental Human Right to Health in the Context of the COVID-19 Pandemic

The Data Selection: Scientific Articles From PubMed Searches and Other Materials From Web-Based Public Data

Articles were selected from the PubMed database due to its large index and collection of world-leading research including scientific journals in health sciences detailing studies on before and after the SARS and MERS outbreaks.

Subsequently, filtering the database was accomplished by searching using the advanced search option in the PubMed website, with no restriction on language, and with the "date-completion" option set between 2003 and May 21, 2020. We used three sets of descriptors, one set for each search, with a total number of three searches, always within the same date range and only substituting the set of descriptors for each search.

The sets of descriptors used were MESH terms: *"coronavirus infections and human rights abuses;" "coronavirus infections and right to health;"* and *"coronavirus infections and court decisions."* The three searches returned, respectively, 2, 26, and 167 articles, totaling 195 articles for consideration. We conducted a search using all the descriptors together but this failed as no results were returned.

The method of analysis we applied was to read the titles and abstract of the articles found within the search described and, subsequently, make a choice as to whether the article should be included in the research. We chose articles that were strongly related to the theme of the present manuscript from the authors' point of view and that matched the designed structure of our research.

For that intent, focusing on specific descriptors that could return important articles related to the theme of this research, we established the three sets of descriptors because we found it important within MESH terms to select *coronavirus infections and human rights abuses,* imagining possible violation aspects in restricting rights within the pandemic. Next, we selected *coronavirus infections and rights to health*, health rights are the main rights to be balanced with priority in the face of other fundamental rights in the context of a pandemic.

For the last descriptor, we decided to include *coronavirus infections and court decisions* aiming to find different approaches to guide decision-making during a pandemic considering fundamental human rights and the rights concerning health prioritization.

Other scientific, journalistic, and opinion articles were included in the bibliography and used to develop the discussion within the research, in addition to the selected scientific articles from the searches performed as described above.

The PubMed material was complemented with data scraping carried out by Boolean operators performed in the Google free database before June 30, 2020. We used the Portuguese terms for *coronavirus, COVID-19, court decisions, lockdown, quarantine, social distancing, prison, rules, legal acts, and jurisprudence.* The selection criteria was based on the relevance of findings in regard to the focus of the present article.

These searches found references to Brazilian judicial court decisions in the scope of the COVID-19 pandemic, which were selected, read, and prepared for inclusion in the text. The authors utilized specific searches for judicial court decision numbers on the sites of the courts, as cited in **Table 3**.

The Points of View of Scientific Articles on Collision of Rights, Decision-Making, and Priority of the Right to Health During a Pandemic

The articles using the PubMed search engine can be seen in **Table 2** to provide a better understanding of the findings. The main findings of the articles found on the theme of pandemic measures are set in this chapter. For example, a research paper on the scope of the Ebola pandemic only recommended quarantine in cases supported by scientific evidence justifying the balance between public security and human rights (6).

Another research paper on the span of the COVID-19 pandemic attributed the closure of the city of Wuhan as an effective epidemic control measure at that location. The authors of that study also noted that cases of the virus would have increased over time if individuals who were infected had not been contained by public efforts (7). In the same sense, another research paper concluded that the lockdown measures were responsible for containing the epidemic in the city of Huangshi (8).

There was a critical article on street and road-blocking measures, as well as lockdown decrees, indicating that they were totally ineffective in containing COVID-19. Travel restriction measures imposed on Chinese citizens by other countries were contrary to international rules established by the WHO, according to this cited research (9).

However, the WHO (World Health Organization) International Health Regulations (IHR) from 2005 (10), in article 43, does not preclude state parties to establish restrictive measures to prevent people's entry based on health risk demonstrated with scientific foundations, and respecting its internal law and international agreements, being more restrictive than international measures adopted by the WHO. However, this needs to be communicated to the WHO and a procedure of verification of its maintenance must be adopted after 3 months of the implemented measure.

On the other hand, the previous research indicates that it is common knowledge that it is necessary to contain person-to-person contagion in the scope of the COVID-19 pandemic in a way to reduce the infected number of people, and that this is possible if people maintain social distancing. Additionally, it is especially important to achieve the development of therapies and vaccines based on science to face the pandemic (9).

From an economic perspective, one article finds that it is questionable that there was justice in the restrictive air traffic measures related to Toronto during the SARS epidemic in 2003, which would have imposed a local loss for the Toronto travel industry of approximately 1.1 billion dollars (11). This research

TABLE 2 | PubMed articles selected and its findings.

PubMed articles Selected		Collision of rights	Governments and institutions decisions	Defense of health rights prioritization or not
6	USA	Public security and human rights	Quarantines and isolation	Only in cases supported by science.
				Quarantine if individuals are asymptomatic and the disease is transmissible before the symptoms appear, but only when benefits outweigh risks. Isolation only when individuals exposed are symptomatic.
7	China	Right to movement and public health efforts	Lockdown	Necessity to effective epidemic control at the location.
8	China	Right to movement and public health efforts	Lockdown	Containing the epidemic in the city.
9	China/UK	Public health efforts and human rights	Lockdown, street closures and travel restrictions	Defends that measures are ineffective to health and are against international human rights rules.
11	Canada	Travel economic rights and public health restrictions	Air trafficking restrictions	Defends that measures were unjust, didn't listen to economic sector and didn't distribute Fairly the burdens.
12	Canada	International right to health and public health efforts	Measures to avoid virus spread	China varies from complying (SARS) to not complying (HIV/AIDS) international right to health determinations.
13	Canada	Travel and tourism sector rights and public health surveillance	Travel restrictions	Arguments that surveillance on health care systems entry would be more effective than travel restrictions (suggest pandemic would be less widespread, end sooner and easily contained).
14	Singapore	Public health efforts, social rights and privacy rights	City closure, quarantines, contact tracing and temperature checks	Defends that besides effectiveness of draconian measures to contain the viruses, it is necessary to consider social impacts on privacy and people's rights, also considering legislative history and biomedical science.
15	Singapore	Public health efforts and rights to movement	City closure, quarantines, contact tracing, temperature checks	SARS is controllable and government measures were effective to control virus spread.
16	Canada	Freedom/Objection of Conscience	Health professionals refuse to attend to infectious diseases	There is a threshold that permits health professionals not to take personal risks and always will be volunteers to do the work.
17	United Kingdom	Collective health rights and individual health rights (Pandemics Scope)	Dehospitalization of long term internment with low health injury	Judicial decision defined that the patient should be dehospitalized to make hospital room for COVID-19 injured patients.
18	Tunisia	Freedom rights and government health based rights restrictions	Restrictions measures by government due to the pandemic	Government has the right and duty to take restrictive measures on freedom rights exercise in a pandemic context, based on the human rights order, the Constitution, the civil and administrative law.
19	China	Right to liberty (against arbitrary/illegal penal punishment) and rights to health	Penal law elaboration and punishment of acts during COVID-19 pandemics	Defends penal enforcements prevailing over liberty rights exercise during pandemics to punish health measures Infringements.
22	Switzerland	Liberty to work as a liberal health professional and rights to health	Determination to closure of health professionals clinics, permitted only emergency care	Measure unique for all health professions, difficulty to define emergency cases, the measure doesn't attend the need of health materials economy, and the measure can increase healthcare crisis by letting patients without necessary attendance.
23	Portugal	Right to liberty and public health	Restrictive, exceptional internment and isolation Measures	Restrictions in these cases, in a pandemic scenario, is intended to contribute to the liberty and health of all. Refusing isolation threatens liberty and health of other citizens.
24	Spain	Liberty and freedom rights, public health and right of access to information	Lockdown, quarantines, exceptional restrictive measures	Scientists claimed to be protected the healthcare system with restrictive measures to liberty rights exercise, and with conceding access to COVID-19 data for better formulating scenarios and possibly interventions in the benefit of public health.
25	USA	Right to liberty, right to social care, protection of the right to migrate and right to free health care	Liberty restriction measures	Liberty restriction measures should be mandatory. Besides, governments should do more specially for the vulnerable, guaranteeing healthcare to migrants, also vaccine and effective treatments, once it exists, free of charge to the population.

(Continued)

TABLE 2 | Continued

PubMed articles Selected		Collision of rights	Governments and institutions decisions	Defense of health rights prioritization or not
26	USA/Canada	Liberty to travel and right to health	Restrictions on air trafficking	Authors argue that air travel restrictions are contrary to the norms of international law. (The article 43 of IHR (International Health Regulations) of the WHO (World Health Organization) does not forbid the air travel restriction, "but such measures shall not be more restrictive of international traffic and not more invasive or intrusive to persons than reasonably available alternatives that would achieve the appropriate level of health protection"). Travel restrictions in past outbreaks were of limited Public Health effectiveness. The necessity of travel bans must be weighed against less restrictive alternatives. Social distancing and contact tracing would be more effective in banning the virus spread. Travel restrictions slowed the spread but not halted it. Governments are always seeking to restrict people's rights. Preventions on the diseases depends on international cooperation and rights protection. Instead of restricting rights States should follow WHO recommendations and practice transparent governance, expand testing capacity, and implement social distancing to protect Public Health. Travel bans unnecessarily provokes economic isolation and rights violation. Freedom rights were infringed with travel restrictions. Instead of travel restrictions States should have isolated people. The world is more secure when countries comply with Public Health necessities and Global Health law.
27	UK/Greece	Migrants rights (fundamental human rights) such as liberty and health rights	Policies of migrants confinement	Such policies of migrants confinement in Europe, and confinement camps, are inhumane. These policies deny migrants human rights such as liberty, health, dignity, work, and so on. This situation makes relevant the urgent need for countries to include universal access to health systems as a right of every human being.
28	USA	Individual freedoms and public health	Exceptional measures based on "Emergency Health Powers"	Due to public health protection the possible measures include compulsory treatments, isolation quarantines, limited liability protections, crisis standards of care for hospitals, powers to test, screen and restrict travel, real time requirements of health materials and products, medications, vaccines, person apprehensions if suspected of infection for treatment and tests for up to 72 hours, confinement of infected persons with clear and convincing evidences. Compulsory Health Power should consider evaluating legal and ethical standards, that should include: 1. significant risk of individuals pose an infectious and dangerous disease; 2. interventions must be likely to ameliorate risks; 3. required least-restrictive necessary means to achieve public health objectives; 4. coercion proportionate to the risk; 5. assessments must be based on the best available scientific evidence, but in emerging crises when science is uncertain it is worth base restrictions on the "precautionary principle". But emergencies in Public Health do not permit coercion that is indiscriminate, overbroad, excessive or without evidentiary support. Home quarantines when correctly taken are much more protective of individual rights liberty and privacy than off-site restrictive measures.

considered that the restrictions would not have been ethical because the WHO did not listen to local authorities before the restrictions were imposed and the burden would not have been distributed equally (11).

On the theme of human rights, an essay indicated that China varied between complying with international determinations of the right to health (in the SARS case) and total non-compliance

(in the HIV/AIDS case). In the case of SARS, China complied with measures to prevent the spread of the virus; in contrast it did not guarantee that Chinese patients suffering from HIV/AIDS had a right to access possible treatments (12).

According to the authors from the above article (12), rights in China do not have the same nature as the human rights in the international arena and in most Western democratic countries,

where rights are considered inherent to every person. In China, there are only concessions of rights made by the government depending on a person's commitment to duties imposed by the government.

The prospects of rights in China, in comparison to other countries ruled by international human rights, are fundamentally diverse, because the rule of international human rights imposes the recognition of rights to every person, without conditions, such as liberty, political rights, dignity, life, health rights, social rights, and cultural and economic rights. Its intensity, extension, and depth vary according to the development stage and richness of a country.

Some dared to predict that if a new epidemic such as SARS appeared, and the local government instead of implementing airport passenger surveillance, affecting the economic travel and tourism sector, had only invested in surveillance at the entrance of health systems, the epidemic would end sooner. The pandemic would be less widespread and more easily contained (13).

Health surveillance and precise restriction measures to avoid public movement in Singapore during the last pandemic demonstrated that fewer people traveling contributed to lower rates of infection. This happened during the SARS epidemic and now has happened during the COVID-19 epidemic (14).

Relating science data to social issues, the research paper demonstrated that measures to restrict and contain an epidemic must follow biomedical criteria and must also consider the social implications of restrictions on rights to movement that affect many people's privacy, liberty, and social rights. The island of Singapore is described to be generally closed during pandemic occurrences with a ring of protection, in conjunction with quarantine, contact tracing, and temperature checking measures in public places (14).

Besides, it was verified through a mathematical model that the interventions of Singapore's government in containing the SARS virus were able to stifle the outbreak of the disease (15). This study did not focus on people's rights collision during the SARS pandemic but tried to answer two questions: was SARS controllable with restriction measures taken by the government and would these measures be effective?

This cited research (15) was successful in proving a positive answer to both questions above. This corroborates the defense of prioritization of collective health rights guaranteed by the measures taken in the SARS pandemic in Singapore. However, the limitation of the study, due to a focus on a mathematical model to prove efficiency of the restriction measures, did not demonstrate a broad view of people's rights in Singapore, which would have been desirable.

Among the possible measures of rights restrictions enacted by governments during a pandemic, there may be attempts to compel health professionals to assist patients with COVID-19 against of their own will (of health professionals). Would that be feasible? This question was raised during the SARS epidemic, where fatality rates were significantly higher than for COVID-19 rates.

The fatality rates of health professionals during both the SARS and COVID-19 outbreak were very high and ethically some health professionals refused to treat infected patients. Could this choice be considered reasonable? In this specific case, because of the rule that permits health professionals to safeguard their own health, the option of not treating infectious patients is justified at least in the context of SARS since there will always be volunteers to do the work, this was the conclusion of other research paper (16).

Judicial decisions on healthcare have social repercussions in the United Kingdom due to the common law system, and the system of precedents (17). An important case mentioned is the case of MB (patient name as initials, not publicized in full in the article for confidentiality reasons) admitted a few years ago to a London hospital.

The hospital sought an injunction to remove the patient from its facility in order to make room for COVID-19 patients. The hospital had already tried to move the patient to a communal home that would meet his needs; however, the patient refused. The judge decided on his removal and prevented him from returning to the hospital without express permission, except if brought by an ambulance [case: University college London Hospitals NHS Foundation Trust v MB [2020] EWHC 882] (17).

In the context of Tunisia (18), the government's right to restrict freedom rights during the exceptional context of a pandemic stems from the international human rights order, the Constitution, and the administrative and civil law normative acts. The same is true in Brazil, and for most state parties in the WHO, and in the same exact order of importance (10).

One research article set in China suggests that local governments must urgently make adaptations to their legal systems with a focus on the penal system, like China has been doing, in order to be able to punish people who fail to comply with restrictive measures aimed at containing the advance of the COVID-19 pandemic (19).

The penalties for these crimes vary from several months of detention to more than 10 years of reclusion. In the article cited (19) the problem discussed is that after the beginning of the COVID-19 pandemic, authorities in China supposedly made some alterations in the penal law so that they could punish people for infringement of measures during the pandemic.

In the Brazilian case, the penal code has a prevision for the so called danger crimes that can be applied to acts that do not adhere with governmental and health measures taken to avoid infections during pandemics, such as articles 131 and 132. The Brazilian penal code also prescribes the epidemic crime (article 267), the crime of infringement of sanitary measures (article 268), and the crime of disobedience (article 330) (20).

Caution is recommended because the main principle of the penal law is the legality principle, according to which the crime and the penalty for its commitment must be prescribed in law before the conduct that will be punished occurs (from the Latin sentence "nullum crimen nulla poena sine praevia lege") (20, 21).

Two additional issues: the criminal approach is different in the Chinese context, for reasons already discussed in this study, and human rights seem not to be fully respected in China compared to the international sphere. Therefore, considering that in criminal facts coercion measures applied to previous facts under the principle of criminal legality cited above, it is not

acceptable that the advance of the pandemic can be contained, an intention necessarily directed toward the future, by law enforcement to punish the authors of crimes.

The penal approach to stop the virus spread is only acceptable if it respects the penal principles, the due process of law, fundamental human rights guarantees, and if it is extremely necessary, as the last choice of the authorities to contain individuals conducting imminent and dangerously deliberate spread of the virus. It is the *ultima ratio* legitimate intervention.

In Revue Médicale Suisse (RMS) (22), medical doctors argue that it is not possible to follow the determination of public authorities for non-urgent cases, the so called *fermeture obligatoire des cabinet medicaux per le Ordonnance 2 COVID 19*, with only permission for emergency medical care being maintained.

State restrictions have even created a definition for an urgent situation, such as one that cannot be postponed to another date. However, the authors claim that there are situations in which it is not possible to clearly determine if it is urgent or not, and that even patients whose conditions are originally not urgent can quickly evolve into an emergency that requires immediate intervention (22).

In Portugal there is context for the application of restrictive, exceptional, internment, and isolation measures indicated for reasons of public health, as detailed by constitutional interpretation and jurisprudence. There are no explicit provisions allowing restriction of liberty in the CRP (Constitution of the Portuguese Republic) in the case of a pandemic, but, as these authors explain, in these exceptional circumstances, restrictions are intended to contribute to the liberty and health of all, since the patient that refuses isolation threatens the liberty and health of the other citizens (23).

In the Spanish context of the pandemic, experts asked the authorities to decree a lockdown and to grant access to pandemic data to researchers, because it is indispensable to guarantee the right to information. This can also contribute to the formulation of exceptional measures to face the pandemic based on facts and scientific evidence (24).

Scientists also claimed, in addition, for the authorities to take more restrictive measures on freedom rights for the purpose of containing the advancement of COVID-19 (24). According to these authors, the Spanish government's timid measures were not enough to contain the pandemic's progress, and it eroded the foundations of the Spanish health system (24).

A finding in an article included in this study stated that people should follow the mandatory recommendations and restrictions, and comply with orders of social distancing. Moreover, governments should do their part, especially for the most vulnerable. For example, guaranteeing social and health care to immigrants, who fear deportation and would hide even if they were sick, causing individual and social damage. Governments must guarantee treatment, and, once a vaccine and effective treatments exist, they must be assured free of charge to the population, to avoid inequalities (25).

As a counterpoint to the idea that restrictions on the right to freedom should prevail to contain the advance of the pandemic, and consequently to safeguard the right to health, some authors advocate that restrictions on air travel are contrary to the norms of international law (26). But as we saw above in article 43 of the IHR, measures that restrict people's entry into state parties of the WHO to face health risk are not forbidden but have to be founded on scientific evidence and have to adhere to a procedure of communication and verification.

According to another study (27), policies of confinement of migrants in Europe, mainly in countries with low to medium income, threaten the efforts to contain the progress of COVID-19 in major European centers. Thousands of migrants do not have access to water, soap, medicines, toilets, and electricity, and they are confined to detainment facilities, such as confinement camps, without basic health conditions (27). These inhumane conditions are perfect for COVID-19 transmission, which can increase the rates of contagion in European centers going forward.

Several authorities in countries like Greece have already been informed of the need to eliminate such confinement camps in the scope of the pandemic, but no such measures were taken. Measures to cope with COVID-19, like those policies of the 2030 Agenda, should include universal access to health care systems for all people as an emergent need (27).

Restrictive and social distancing measures do not work and are not possible for confined migrants, in this inhumane scenario. All the efforts to contain COVID-19 could be in vain if there remain migrant confinement camps in the Mediterranean.

In the light of the declaration on January 31 2020 that the COVID-19 pandemic in the United States of America was an emergency and a clear exceptional situation of crisis, the government had a special responsibility to carefully balance the protection of public health and individual freedom (28).

The present article is about unveiling pandemic extreme measures that can be taken by governments and health authorities and that make it possible to better protect rights to freedom and health, guaranteeing human rights protection and promotion in a solidarity and collective way during a pandemic.

Collision of Rights to Freedom in the Face of the Rights to Life and Health During the Novel Coronavirus Pandemic

Brazilian State Policies to Face the Pandemic and the Judicialization of Collisions of Fundamental Rights in Brazil in the Scope of the COVID-19 Pandemic

Fundamental rights in Brazil are based on its Constitution. There is a claim that fundamental freedoms and their exercise by individuals and groups of people collide with the right to health in the scope of the current pandemic of COVID-19, which is similar to what happens in different parts of the world, as described in **Table 2**.

In the COVID-19 context we must admit, by the data collected (**Table 3**), that the head of the Federal State of Brazil has adopted contradictory measures during the pandemic. It is also possible to detect that he does not deliberately implement global health recommendations, and rejects any coordination with local governments to cope with the pandemic effects and containment.

TABLE 3 | Examples of Lawsuits in Brazil in the collision of fundamental human rights during the Coronavirus pandemic.

Lawsuit proposer	Action requests	Court	Decision
1. Democratic Work Party (by Brazilian Federal Deputy).	Unconstitutionality of a federal provisional law that removed the competence to impose restrictive measures from Brazilian States and Municipalities.	Brazilian Supreme Federal Court.	Injunction granted to maintain the competence of the Union, States and Municipalities to impose restrictive health measures during the pandemic[1].
2. Federal State of São Paulo.	To unblock the roads on the coast of Caraguatatuba.	São Paulo State Court of Justice.	Suspension of the injunction and the judgment that blocked the roads[2].
3. Brazilian Federal District.	Mandatory submission to diagnostic examination and home isolation in one necessary case.	Federal district court of justice.	Injunction granted[3].
4. Municipality of Ariquemes Rondônia	Injunction and judgment suspension to permit open trade within the city.	Superior Court of Justice.	Suspension not granted[4].
5. Citizen 1[a]	Preventive *Habeas Corpus* not to be submitted to social isolation.	Superior court of justice.	Injunction not granted[5].
6. Citizen 2[b]	Home Prison.	Superior court of justice.	Measure approved[6].
7. Citizen 3[c]	Home Prison	São Paulo state court of justice.	Measure not approved[7].

Source: Data collected and prepared by the authors in the named courts' databases, after search and scraping data in the Google database with options described in the 'Data Selection' section above.

Chart legend: A: Citizen 1 did not want to be hypothetically submitted by a government rule to social isolation in case of infection by the novel coronavirus. The court decision did not permit the citizen avoidance of the health measures adopted by the government. B: Citizen 2 was a male jail prisoner accused of drug trafficking caught with 101 g of crack and 99 g of cocaine and would have committed the crime without violence and was preventively arrested without conviction—overdue preventive detention. The court understood that in exception, because of the COVID-19 pandemic, and the fact that the crime was committed without violence or serious threat, to substitute the institutionalized prison to the home prison measure, according to pandemics guidelines recommended by the CNJ (National Counsel of Justice), prevailing a preventive measure to the health benefit (cope the coronavirus infections) over the criminal procedural law enforcement of the maintenance of the jail prison decree due to the gravity of the crime (great amount of drug apprehended) and general reasoning of jail preventive imprisonment in the protection of the public order. C: Citizen 3 was a female jail prisoner, mother of a child, condemned for drug trafficking with a community service punishment not complied to. This was replaced by arrest for 2 years, and the measure required was not approved due to the judgment consideration of the child's best interest in maintaining distance from the mother. 1: Direct Action of Inconstitutionality (ADI) n° 6341 from the Supreme Federal Court (STF) stf.jus.br, search of law suit tool by class (ADI) and number (6341). 2: Suspension of Injunction and Sentence (SLS) n.° 2054679-18.2020.8.26.0000 from the Court of Justice of the São Paulo State (TJSP) tj.sp.jus.br, search of law suit tool with the number. 3: Civil litigation n.° 0701858 04.2020.8.07.0018 from the Court of Justice of the Federal District (TJDF) tjdft.jus.br, search of consultations tool, public consultations, 1st instance, with the number. 4: Suspension of Injunction and Judgement (SLS) 2697 RO from the Superior Court of Justice (STJ) stj.jus.br, search of law suit tool with SLS 2697 descriptor. 5: Habeas Corpus (HC) 576058 DF 2020/0095453-4 from the Superior Court of Justice (STJ) stj.jus.br, search of law suit tool with HC 576058 descriptor. 6: Habeas Corpus (HC) 564736 SP 2020/0054426-4 from the Superior Court of Justice (STJ) stj.jus.br, search of law suit tool with the descriptor HC 564736. 7: Habeas Corpus (HC) 20602463020208260000 from the São Paulo State's Court of Justice (TJSP) tj.sp.jus.br, search of law suit tool with the number.

This can also be demonstrated in the science denial discourse of the head of the State (29).

On the other hand, the Senate of Brazil decreed, after the President of the Republic requested, based on the Constitution, a state of public calamity to cope with the pandemic using economic measures. A state of emergency in public health was determined by the Ministry of Health to cope with the pandemic and adopt necessary health measures.

It also established, by law, the possibility of the government adopting, among other measures, the restriction to movement of people, compulsory submission to diagnostic tests, social isolations, quarantines, lockdowns, and the request of private assets for the use of the State. It was also declared by law that all people in the scope of the pandemic have the right to be treated free of charge. These are the main potential measures to be taken by the country's government to face the pandemic (30), at federal and local levels.

State and Municipal governments in Brazil, within the scope of their constitutionally guaranteed competence in health issues, have addressed normative and administrative acts (pandemic measures) to restrict the movement of people, established compulsory isolation of individuals, and have made determinations to carry out diagnostic tests on specific individuals. They likewise established quarantines, social distancing rules, and other restrictions such as road and street blocking, as well as specific lockdown measures.

There have been judicial decisions on conflicts related to the pandemic, and recurrent judicial rulings recognizing the prioritization of the right to health that justifies restrictions in freedom rights. The most important and iconic of the conflicts that have occurred so far was at the legislative initiative of the President of the Republic in which he aimed to prevent State and Municipal governments from adopting measures to restrict the exercise of freedom rights, such as social isolation, quarantine, and local lockdowns.

This was provisionally prevented by the Federal Supreme Court. The Brazilian President tried to avoid local governments having to balance the fundamental rights to health access under their constitutional competency and the freedom fundamental rights, in order to be capable of determining pandemic measures

to cope with the spread of the virus, and the Brazilian Supreme Federal Court did not permit that limitation by the President, which would have been terribly unconstitutional.

There was a declaration by the court that State and Municipal governments, as well the Federal government, can legislate on health under the Constitution rules and principles, but especially in the pandemic scope, in order to face the emergency of public health.

Conflicts and collisions of rights have been judicialized in several Brazilian courts. The matters are diverse, such as lawsuits that have been filed to release prisoners from risk groups to avoid the damaging consequences of COVID-19. In this kind of situation, the right to health only sometimes prevailed over the State's right to punish in the precarious context of the pandemic, as demonstrated in **Table 3**.

There are also cases of compulsory testing and social isolation. In such cases, the right to health has prevailed to the detriment of individual liberties in the cases verified (**Table 3**)

It is interesting to note that, in a way to prioritize health rights in habeas corpus petitions, in order to maintain social distancing, the claim verified has been that house arrest (relative liberty compared to prison) is necessary for inmates, in the risk group or with special conditions, to serve out their sentences or provisional prison measures.

In a case in which the judicial decision was to concede the mandamus, the court understood that imprisonment during this pandemic conflicts with health rights protection, and so it made the prioritization of health rights (Citizen 2, **Table 3**).

Some of the most relevant types of lawsuits involving the collision of principles which establish fundamental rights that have been found in the Brazilian pandemic situation are listed in **Table 3**. The right to health in the majority of the cases selected (5–2) prevailed over the other interests in the context of the pandemic.

The Weighting and Balancing of Rights in Collision

There are theoretical guidelines in legal doctrine for making judicial decisions in the face of a collision of law principles and for conflicts of legal rules. On the other hand, in the theories of the field of justice there is a consensus that "A Theory of Justice" from John Rawls is a watershed moment (31, 32).

John Rawls is the theorist that, from the second half of the 20th century onwards, changed the focus of the justice issue in a liberal way, focusing on the fairness of the justice, placing it in a set of rules for the better stand of liberty to all (egalitarian liberty) and of democratic equality completed by the sense of the principle of difference (31, 32).

It is recognized in doctrine that justice was, in Rawls's theory, replaced in a different focus considering the distributive sense of just measures to all, and that Rawls conceived his theory based on criticizing the utilitarianism ethics.

In summary, the justice theories have developed since Plato's concept of justice as happiness of the city and of its guardians, and Aristotle's concept of justice as equity. Subsequently, justice was connected to Hobbes's and Locke's concepts of State and Justice, founded on the power of the strongest due to a necessary obedience of the sovereign, and based on the right to property, respectively.

Justice conception was completed in this chronology by the utilitarian theories of Jeremy Bentham and John Stuart Mill based on the principle of happiness. After this evolution until the 19th century there was not another widely relevant new theory of justice before John Rawls.

At the other side of the current approach of this research, hard decisions in which fundamental law principles that contain the fundamental rights of people collide, Ronald Dworkin sets the problem assuring that rights only apparently collide because constitutional rights, at his notion, are neat and clear concepts that need to be known by the interpreter, from a point of view of the internal theory, without external influence of other fundamental rights, according to the concept that the principles are found in their internal content (4, 33).

But Dworkin accepts the balancing and weighting of the interests involved in such cases, but in a hidden way, with justification deficiency to the theory (33). At his side, Robert Alexy delivered an interpretation of law rules and principles, and in his conception of these optimization commandments (constitutional principles), from an external theory, it is necessary to balance and weigh principles and assume rights collisions, in a construction of a well-accepted technique to solve collision of rights and principles in court and state decisions (4, 33, 34).

Supported by the theory of principles by Robert Alexy, and the concepts of rules and principles by Ronald Dworkin, and also the horizon of liberty and equality borrowed from John Rawls's "A Theory of Justice," it is possible to discuss the established rules created to face the COVID-19 pandemic in the context of the scenarios given by the selected PubMed searcher articles, in several countries in the world and different legal systems, considering also the Brazilian constitutional context in comparison.

Fundamental rights are essentially relative in the sense that there is no fundamental right, based on a principle, of absolute nature, according to the prevalent interpretation of the Constitution. For Pildes (35), although constitutional theory and political philosophy understand that rights are individual trumps for autonomy, dignity, and liberty against decisions in the common good, constitutional practice indicates that rights function in another sphere rather than acting in atomistic protection of individual interests. For this theorist, rights serve as tools for courts to evaluate the social meanings and dimensions of governmental action. In this way, rights are means of realizing the common good.

The exceptional situation of the COVID-19 pandemic and the need to face the public health emergency make it possible for authorities to balance constitutional principles, and to create and enforce legal rules that impose direct restrictions on the exercise of individual and social rights in the prioritization of the common good. Thus, greater constitutional and democratic values can prevail amid the pandemic.

The rights to life, public health, and human dignity are examples of fundamental rights of unquestionable social and legal importance. Due to the pandemic these fundamental human rights take precedence in a weighting of values in comparison to the mere right to freedom dissociated from the values of solidarity, self-protection, precaution, and care.

For most general liberty exercise rights to prevail over the right to health during a pandemic, they must be linked to solidarity, self-protection, precaution, and care. Examples are the cases of health professionals that refuse to assist COVID-19 patients, or of prisoners in Brazil, or of migrants in Europe or near the Mexican border in North America, whose restrictions to liberty in prison institutions render them unable to protect themselves from the virus spread in the pandemic, which is unacceptable.

These findings are based on the legal system, on constitutionalism, and the normative nature of constitutional principles, and are observed in the literature. In cases of collision of rights, the fundamental rights that carry a social relevant value, notably the rights to health, to liberty with solidarity and self-protection, to equality, protection of all human lives, promotion of human dignity, and social justice efficacy, must be, in all of these cases, prioritized as a necessary respect of the rule of ethics and rule of law that must be necessarily attended.

ACTIONABLE RECOMMENDATIONS

In his Theory of Justice, Rawls (32) locates political action at the encounter between the rationality of the modern political social contract and geometric morality.

In his work "A Theory of Justice," Rawls (32) assumes that in each society all individuals must be equally free, autonomous, and democratically equal (principles of egalitarian liberty and democratic equality). No one may be subject to discrimination or exclusion, and institutional objectives must move in the direction and primary purpose of poverty reduction and, therefore, of social ills.

This theory of justice is complemented by the principle of difference, according to which institutions must be structured based on the observation of social inequalities, and institutional practice must produce, in the long run and in the future, greater benefits to the least favored in society.

From the viewpoint of the theory of principles, by Robert Alexy, according to Virgílio Afonso da Silva (34), there is a possibility of conflict between legal rules and of collision between legal principles which make up the fundamental rights. But it is also possible that a collision occurs between rules and principles, which is another way in which a collision between principles may take place (34).

Ronald Dworkin, in his work "Taking Rights Seriously" (36) addresses the issue of balancing law principles and the weighting of them as a need to decide, e.g., hard cases for which there are no decisions made yet but they certainly must be made. Some bases of these themes were previously addressed by the author earlier, in 1967, in an article entitled "The Model of the Rules" (37).

Dworkin establishes, in a way that is also indicated by Alexy, and is vastly accepted in law theory that a conflict between two rules has to be solved at the level of validity, with only one possible answer: one of the rules is valid, and the other rule is not valid.

On the other hand, Alexy indicates that in a collision between two principles, the nature of the collision is based in the "factual supports" of the principles, which includes in it the "protection scope of the principle" and the "governmental intervention" (34).

The "factual support" in Virgílio Afonso da Silva (4), on the other hand, also includes the "constitutional reasoning" in the conception of the constitutional principle to define whether the rights restriction based on rights collision, e.g., is constitutionally permitted or not.

Therefore, the technique to solve rights collision is to weigh the related principles, balance them, and select the one with greater weight, applying the proportionality principle conception to decide which is the most relevant principle to prevail for the governmental action to face the issue (facts) addressed, in order to restrict fundamental rights exercises in a constitutionally respectful pattern. And this weight and importance must be in accordance with the fairness of the decision for that situation (32, 34, 36).

Virgílio Afonso da Silva developed his own concept of the "factual support" based on Alexy's theory to clarify the constitutional permission of the fundamental rights restriction under a necessary verification: Scope of protection of the fundamental right + Governmental intervention + Constitutional Reasoning = Constitutional and Acceptable restriction of a Fundamental Right Exercise, case by case, necessarily considered the proportionality principle (4). If there is no constitutional reasoning for the measure/intervention adopted to restrict fundamental rights, the State's intervention in this case will be unconstitutional.

When two principles collide, e.g., the principle of individual liberty and the principle of public health, it must be assessed which principle should prevail in that specific scenario, considering and deciding in favor of the most fair decision to take (according to Alexy, the maximum protection of the fundamental right), always balancing and describing the weights of the law principles (rights) related to the situation. From the notion of the right to liberty that can be limited, in a Theory of Justice by Rawls, it is considered that liberty can be limited in favor of everyone's own equal liberty (32).

Added to the notion of the emergency of public health, everything indicates that the right to health in the context of the current pandemic must prevail over the right to unrestricted liberty of movement of people, because the health right in this pandemic carries more legal and moral weight than the liberty exercise with some necessary restrictions, considering also that the liberty exercise can never be without any restriction, for the common good of all people.

Thus, the legality and legitimacy of the extreme measures that restrict freedom rights in the strict duty to cope with the COVID-19 pandemic are well-justified if they are based in fairness and on solid facts, better scientific evidence, acceptable rules and constitutional principles, and if they are made by the competent authorities. Those measures can also be accepted if they use the least aggressive and restrictive measures possible to achieve the public health goal, if they do not cause direct or predicable harm to the life, dignity, and health of anybody, if they prioritize the health rights protection of the most vulnerable in the first instance, and if the measure taken is proportional to the risk faced and to the better protection of indivisible and interconnected fundamental rights.

In the Brazilian case, there is a regulation of social restrictions based on Federal and Local normative acts that settles legal rules during the pandemic. These rules inform other normative acts, improved per locality, which can be more restrictive but not more flexible than the Federal rules or the Federal State's rules. Hence, the normative prescriptions can be improved and adapted in local rules, on the level of the State, the Municipal, and the Federal District governments.

Accordingly, a potential collision of norms of broad spectrum of freedom rights exercises in the face of the established rules of health protection, in the context of the pandemic, to better protect health rights and healthcare systems demonstrates the possibility of the collision of a constitutional principle (rights to freedom) with a rule of protection of the right to health (restriction measures).

In this case, as described for similar abstract situations by Virgílio Afonso da Silva disserting on Dworkin's and Alexy's concepts (34), a principle (of liberty) is restricted by a rule (pandemic extreme measures set by law) so that other principles can prevail—in this case the principle of public health (which is the foundation of the right to health).

The Supreme Federal Court in Brazil has several precedents establishing that whenever health and life collide with constitutional principles less important than life (life with dignity is the most important democratic principle) (5), the rights to life and to health must prevail.

The US Supreme court on May 29, 2020 rejected a church challenge to California's COVID-19 restrictions by a 5–4 vote. Chief Justice John Roberts joined the liberals and said in his opinion that he would not join conservative judges escalating efforts to override public health measures in the name of religious freedom. It was set that "the Supreme Court will not facilitate the spread of a deadly virus in the name of the first amendment" (38).

In the context of the pandemic, the acceptable measures to restrict individual and social rights are strictly intended to contain the spread of the SARS-CoV-2 virus always with the aim of preserving public health and people's lives.

In an ethical approach there is the necessity to consider the argument of utilitarianism decisions to achieve major happiness as a finality (principle of happiness), at least to most people. The point defended by John Stuart Mill's utilitarianism (39) can be a point of departure, but not the foundation of the ethical decision. Other important legal and ethical implications must be considered for decision-making during a pandemic.

No life can be forgotten, that is the point. Decisions in such situations that involve freedom rights exercise, health rights access, and protection of healthcare systems during pandemics, must be decisions that do not directly affect anyone with imminent risk of death or health injury, and it must also predict the consequences of extreme decisions, in its foundations for not to put in real and imminent risk the human dignity of any person. For example, an extreme pandemic measure that put someone in imminent risk of death to protect the health right of most people is not a feasible and fair ethical or legal decision.

That is why the "rule utilitarianism" is, till today, a good way to make ethical decisions guided by law, as it establishes that "an act is morally right if and only if it is (or is likely to be) in accordance with an acceptable rule (or set of rules), where the acceptability of a rule is determined on utilitarian grounds" (40).

The present study developed **Table 4** with resumed information of the recommendations found within this research for a guideline on taking pandemic measures fairly to the fundamental human rights and based on acceptable ethical rules.

CONCLUSIONS

It is legal and legitimate for governments to adopt extreme measures by balancing and weighting constitutional principles to adopt restrictions on the fundamental rights exercise that collide with the fundamental rights to health in situations of a pandemic, on the level of the Constitution. It is extremely necessary to protect rights to life, dignity, and the health of all. The prioritization of them in the face of freedom rights divorced from the solidarity, self-protection, care, and respect of autonomy, values that are important to societies, must be considered in health decisions.

To face the collision of rights (on the level of constitutional principles) it is necessary that facts have not yet being legislated specifically by a rule, or the specific rules are imprecise or incomplete, or if the rules (indirectly the principles that forged the rules) collide with other fundamental principles based on the Constitution. For that reason, these situations need the constitutional principles that address fundamental human rights to complement or define the legal significance of the governmental intervention to be applied. Pandemic occurrences must require this special legislation (rules) and precedent rulings of courts to determine the legal conformation of rights restriction measures for decision-making.

The conflict of general legal rules and special rules for a pandemic, at the other side, must be decided at the validity level, in which a pandemic rule must prevail when applied to the current situation, by the application of the prevalence of a special rule instead of a general rule, according to the *Latin sentence lex specialis derogat generali*.

If one intends to achieve a state of social justice during a pandemic, at the same time the government must first protect the most vulnerable. Then it is necessary to protect all people's rights to health and liberty with solidarity, or health equity will not be possible, mainly in impoverished communities, in prisons, and in peripheral regions of the world.

Most of the articles selected in the present study legitimize social restraint measures to face the increase in the number of infected cases in the pandemic by factual evidence of contribution to decreasing the contagion and spread of the virus.

The same direction is noted in **Table 3** data, in which seven court decisions face extreme measures related to the pandemic, and in its majority (5–2) they give precedence to the protection of the rights to health related in the case (only the cases 2. and 7., the "unblock of roads" and the "Citizen 3" cases, were not decided

TABLE 4 | Guidelines of conditions to orient authorities to take pandemic measures respecting acceptable ethical issues and fundamental human rights.

Extreme measures and its flexibilizations orders in pandemics must be, concomitantly:	**BASED IN:** Solid facts **OR** Better scientific evidence **AND** Better protection of all people **OR** Minor public health risks **AND** Minor individual health risks **OR** Prioritization of individual or collective health rights protection	**NOT CAUSE INJURY DIRECTLY TO:** Life **AND** Health **AND** Dignity **OF ANYBODY; OR IS LIKELY TO (PREDICTABLE TO):** Cause no harm to anybody **AND** Better and in first place favor the most vulnerable	**FAIR IF VALID TO:** All persons in the same conditions **OR** One person or group in specific condition	**TAKEN WITH:** The least aggressive effort to achieve the aimed public health benefits.	**RESPECTFUL TO:** Proportionality between the public health measure taken and the pandemic related risk faced.
Home quarantine					
Off-site quarantine**					
Social distancing					
Social isolation**					
Compulsory testing**					
Compulsory treatment**					
Compulsory vaccination**					
Person apprehension*					
Schools closure					
Schools reopening					
Travel restrictions					
Closure of clinics					
Closure of stores					
Closure of services					
Jail prison order*					
Home prison order*					
De-hospitalization					
Confinement* detention					
Cities closure					
Contact tracing					
Temperature Checks					
Streets closures					
Roads closure					
Lockdown measures					
Private and health goods/materials apprehensions					
Compulsory use of masks					
Commerce, stores, services reopening					

Table Interpretation: (A) * These measures must be decreed by a criminal judge, in the Brazilian law system, after a requirement of a competent public authority, and must be related to a crime investigation on course or related to a conviction settled by a criminal judge (21). (B)** These measures can be taken by public administrative authorities due to the COVID-19 exceptional Federal and States legislations in Brazil, but, for a systematic view of fundamental rights, in case of enforcement measures with the use of public force against individuals physical liberty exercise, it is strongly recommended, for involving people's direct subtraction of liberty, to count with an ongoing criminal investigation and legal order emanated by a criminal judge after the occurrence of a crime related to the pandemic theoretically practiced by the individual (except in the cases such as of vaccination and of treatments with no iminent risks to life, that cannot be forced by physical strength). Isolation measures recommended are obligatory but if physical use of force to make it effective is not needed, the judicial order is also not necessary. But further criminal effects can arise if the individual deliberately do not accomplish with the measure determined by the public administrative authority (isolation after testing positive for COVID-19). These recommendations are founded on the due process of law principles and it's criminal law procedure rights and guarantees (21). (C) The measures of compulsory collecting samples and vaccination do not need a medical doctor prescription to be obligatory in Brazil. On the other hand, the measures of medical examinations, laboratorial tests and treatments, and social isolation must be abiding to medical prescription to be obligatory to the individual in Brazil due to the pandemic legislation in effect (30). (D) The other measures in the Brazilian scenario can be made by public administrative action, due to Executive and Legislative authorities' norms, under their competency to legislate and administrate the health subject of law, also with the use of police force. (E) In case that the competent authorities do not act in their public duty or act against it, the Judiciary power can be provoked to act and deliberate in all these measures, regarding to its legal competencies, by court decisions, also founded in the principle of prohibition of the non-liquet (and the principle of no judgement avoidance) according to which the Judiciary Power in Brazil has the duty to decide in all questions that are demanded in courts (21). (F) If the pandemic exceptional/extreme measure and its flexibilization measure has all five affirmatives to the conditions above, the related measure is fair and accomplish with the fundamental human rights of all, aiming to protect and to promote rights to health in a pandemic scenario. In this case, according to the "Rule utilitarianism," the measure taken in the case fact is also accordant with an acceptable and ethical rule and that is a moral right act also based on utilitarian grounds.
Source: Data prepared, interpreted from the research findings, and formatted by the authors, from the data related on the references section of this research.

invoking the need of the extreme measure adopted to protect the right to health, as described in **Table 3**).

Nevertheless, there are some selected articles in this study that claim the alleged ineffectiveness or limited effectiveness of containing the transmissibility of the virus by restricting the movement of people, and there are also respectful researches advocating the contradiction of the travel restrictions to the rules of international law. These viewpoints are worth considering despite their limited influence due to the adoption of extreme measures since the SARS pandemic of 2002-2004, but they make an important point by indicating that it is necessary to consider the balance between the health protection of everyone and the preservation of the rights to freedom of all and all related fundamental rights that can be restricted in their exercise by pandemic extreme measures adopted by governments based on scientific evidence.

Restrictive measures must abide by the legal and constitutional systems, the social conditions and must be in harmony with the notion of relativity of fundamental rights. There exists the feasibility that health rights rules must take precedence over general freedom rights in the scope of a pandemic. The present research created guidelines for authorities to take during a pandemic when adopting extreme measures that affect fundamental rights exercises in a way of respecting the fundamental human rights of all and for the consideration of acceptable ethical decisions in this same direction. The guide is summarized in **Table 4**.

AUTHOR CONTRIBUTIONS

JS concepted the theme and idea of the research, indicated a law science author for consideration, and redacted its first manuscript. PS made the research of scientific articles used within this article, selected and interpreted them, selected the law science authors to be cited, concepted the structure of the research, and comparison of data. Also designed the tables, the article type, format, sections, headings and their nomenclatures, the abstract, the keywords, and the others sections of the article. Wrote the final version of the manuscript submitted, prepared the template for the journal submission, and designed its english version that was revised by experienced translators. FA coordinated the research and the writing process of the manuscript. IB, PM, and ET-C analyzed the data collected and suggested modifications and made revisions. LA conducted the process of creation, coordinated the authors, made suggestions in the conception and writing of the manuscript, and contributed within the data analysis. All authors contributed to the article and approved the submitted version.

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Who Gets Cured? COVID-19 and Developing a Critical Medical Sociology and Anthropology of Cure

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Keywords: COVID-19, cure, sociology, anthropology, vaccine

INTRODUCTION

In this opinion piece, I argue that a sociology and anthropology of cure is accelerated by various features of the scientific and social responses to the COVID-19 pandemic. I illustrate how the pandemic has made the general public rethink popular notions of "cure," foregrounded ethical dilemmas and inequalities in who has access to "cures" and also revealed deep uncertainties correlated to a future where there is no such thing as cure anymore. Such developments in the pandemic response illustrate the need for a critical interdisciplinary agenda to interrogate the social, ethical, cultural, economic, political and technological innovations of cures nationally and internationally.

The race for a vaccine for the SARS-CoV-2 virus that causes COVID-19 illustrated the urgency to find a cure during a pandemic but also deep anxieties, as the general public realizes they have to leave behind absolutes of "cure" and deal with uncertainties of who now gets cured? In medical sociological and anthropological literature, absolutes of cure have long been criticized in research, amongst others, focusing on changing ideas of: inequalities in who becomes incurable or curable, for example, during the HIV/AIDS epidemic (Schoepf, 2001; Nguyen, 2010), inclusion in clinical trials (Petryna, 2009), or due to genomic advancements (Inhorn and Wentzell, 2012); environmental, lifestyle and embodied (epigenetic) risks which have reconceptualised understandings of nature and nurture (Kavanagh and Broom, 1998; Lock, 2013; Gale et al., 2016), as "situated biologies" mean rethinking notion of bounded bodies in favor of how biology is affected by environment (Niewöhner and Lock, 2018); expectations and hopes of new biotechnologies and artificial intelligence that bring to the fore the way in which scientific advancements can politically shape subjectivities, temporality, emotions and care (Brown and Michael, 2003; Brown, 2005; van der Niet and Bleakley, 2020); "promissory futures" of biomedical and scientific innovations, such as in the field of regenerative medicine, become correlated to neoliberal policy-making and economic investments (Brown et al., 2006; Selin, 2008; Morrison, 2012); novelty, for instance in epigenetics, becomes socially constructed (Pickersgill, 2020); clinical forecasting is relationally imbedded and negotiated in clinical practices (Timmermans and Stivers, 2018); and dealing with uncertainty of conditions with no cure, where instead experiments become perilous options for patients (Fox, 2020). The above is just a sliver of the breadth and depth of knowledge built on a continuum of cures, but the very notion itself of "a cure" and how the concept is changing, is never explicitly questioned as such.

Yet, as illustrated, just as comprehension of COVID-19 is marked by social understandings of inequalities in infection, environment, prevention and intervention (Lupton and Willis, 2020; Trout and Kleinman, 2020), knowledge of cure is socially and culturally informed too. Public health pandemic responses to COVID-19 have focused on scaling up disease prevention and control efforts, public health information, laboratory systems and development of

private and public partnerships to develop diagnostics, therapies, antiretrovirals and vaccines. Furthermore, critical social commentaries have been noted in terms of ethics of access to: care; life-saving equipment like ventilators; therapies (e.g., remdesivir); vaccines; as well as debunking the idea of recovery and immunity.

Presently, with hopeful vaccines on the horizon (Horton, 2020), a "critical bioethics of cure" is developing, informed by differing ethical norms and values in society, associated to who gets access to vaccines and how they will be allocated (see, Emanuel et al., 2020). For example, in the United Kingdom (UK), the disability community has warned of overt discrimination in lack of ethical inclusion in pandemic preparedness and response (Armitage and Nellums, 2020), "ableism" (Campbell, 2009) of foregrounding of able body in withholding, triage or rationing of care as cure, as well as warning of "social" deaths in our disablist language use, and real deaths in revoking of rights in health and social care policies (Abrams and Abbott, 2020; Tidball et al., 2020).

Disability studies researchers, while long critical of the medical model and curative imperative (Clare, 2017), are pointing to an unethical "curation" or "social sorting" (Grover and Piggott, 2010) in how the able body now gets protection against an infection, access to critical care, therapies and vaccines (Scully, 2020), according to a new curative "imperative of health" (Lupton, 1995) or distributed "logic" of cure (Mol, 2008). The logic of cure describes how an "imperative of cure" becomes normalized in our social and cultural lives and is increasingly commodified but not distributed equally nor a choice. Neoliberalism and promises of late modernity have been incorporated in such a logic of cure, in terms of a "biopolitics of cure" in how patients, doctors, researchers, pharmaceutical companies and financial investors create momentum around specific infectious diseases, genetic disorders, chronic or neurological conditions and now in its acceleration for the general population during the COVID-19 pandemic.

RETHINKING CURE

COVID-19 elicits a variety of human immune responses (e.g., acute, chronic, mild, and also uncertain recovery) that we do not yet understand, in both people who are seemingly healthy or have pre-existing conditions. We know that that certain sections of the population (e.g., linked to structural inequalities, ill-health, co-morbidities, age, disabilities and biology) are at greater risk from COVID-19 (Bentley, 2020). People who have COVID-19 can also be asymptomatic carriers (see Gandhi et al., 2020), as well as possibly get reinfected after recovery, further complicating our ideas of symptoms and signs, as well as clinical and social understandings of how the virus spreads. While patients recover, it does not seem as if immunity is always long-term or sustained, calling into question ideas like giving survivors "immunity passports" (Andersson et al., 2020). Similarly, "vaccine certificates," "identification cards" or "vaccine passports," which while clinically and practically useful, could open up the door to legal, ethical, and social issues, such as discrimination of those without vaccinations (Phelan, 2020).

Further complicating notions of immunity and long-term cure, is that COVID-19 also has "impairment effects" (Thomas, 2007) in creation of impairments (e.g., organs), affects senses (e.g., smell) and emotions (e.g., post-traumatic stress disorder) with physical and psycho-social long-term rehabilitative needs (Halpin et al., 2020; Mandal et al., 2020). As such, Greenhalgh et al. (2020) have noted the emergence of patients who have survived COVID-19 but whose clinical and mental health recovery is slow and long, noting that these patients are termed "long haulers." New "biosocial" categories (Rabinow, 1996; Rose, 2009) of patients are thus emerging around social identities of uncertain survivorship from COVID-19, as we discover more about how COVID-19 affects people (Kingstone et al., 2020; Ladds et al., 2020; Miyake and Martin, 2020; Philip et al., 2020).

While a sociology of diagnosis (Nettleton, 2006; Jutel, 2009) can be helpful to comprehend patient needs for a medical diagnosis, people with long COVID-19 struggle with the physical and mental health uncertainties of recovery and realization that there may only be a partial survivorship or indeterminate forms of cure (see Ladds et al., 2020). Similarly, there is no certain prognosis or forecasting that can be made about the future of how recovery from COVID-19 survivorship will unfold alongside other conditions, and this influences treatment options and experiences of primary care (Kingstone et al., 2020). The current medical emphasis is still on comprehension of the embodiment of curative processes and examining prognosis, treatment and responses to therapies, rehabilitation, mental health support and how survivor experiences can become linked to prevention efforts.

Attending to risks of COVID-19 and mitigating those through policies such as lockdowns, means the indirect effects of who does not get access to diagnosis, therapies and curative promises in the NHS and whose health and impairment is ignored, has been neglected in research. As have the social realities of the thousands of people who have been told to shield because they are severely clinically vulnerable. We do not yet understand the psychological and social impacts on this population group of long-term shielding and messages of "vulnerability" directed toward them. They and their loved ones have had to deal with the idea that survivorship from COVID-19 may not be a possibility for them, as well as having heightened levels of risk to negotiate. What has been the physical and psychological impact of such heightened risk work of staying well? There will also be people within this group that will survive COVID-19 but we don't know if there is a continuum of mild, moderate and severe short or long-term effects, nor if there are more curative possibilities that will be created in the future?

PROMISSORY OR UNEQUAL FUTURES?

Promising candidate vaccines and research initiatives have raised local and global public hopes and expectations of promissory futures (Brown et al., 2006) of living COVID-19 free and returning to a normal life. However, these hopes have been

tempered by clinicians, academics, scientists, and philanthropists involved in pandemic efforts noting the need for more long-term research about effectiveness of vaccines (Horton, 2020). For example, while the Pfizer/BioNTech, Sinovac and Moderna mRNA candidate vaccines appear to offer initial effectiveness, results have yet to be published scientifically and appraised by national regulatory bodies (Horton, 2020), although the UK has approved the Pfizer vaccine. Similarly, while the Oxford/AstraZeneca candidate vaccine has also reported high rates of efficacy, dose errors meant more testing was needed. In addition, UK's Royal Society The DELVE Initiative (2020) have warned difficult medical, political, ethical, economic, cultural, gendered and social questions remain about vaccinations, such as equitable allocation and their long-term effectiveness.

The UK's policy responses have been steeped in self-interested nationalism, for instance, by not engaging in European public-private partnerships or research platforms and insisting on British development of UK vaccine (Sharpe et al., 2020). Likewise, the UK's public health arguments and pandemic responses often emphasize individual civic responsibilities for the common good (e.g., to get tested or vaccinated) rather than broader structural arguments about "affordability, resource allocations and accountability" that the government is responsible for (Forman and Kohler, 2020). Very little policy attention has also been paid to the need to rebuild trust nationally and internationally in government and health services, for instance, due to impact of COVID-19 on ethnic minority communities and health care professionals, who are also most affected by health inequalities, structural racism and history of medical mistreatment (Bentley, 2020). Surveys have reported that those most affected by COVID-19, are more likely to report fears and less likely to want to be the first ones allocated to participate in vaccination efforts (see Thorneloe et al., 2020). This also raises further questions about accessibility of vaccines, if there will be multiple offers of vaccinations and if people can choose if they want to be vaccinated or not, and with which vaccine? What types of choices will people have? Will those be constrained by nationalism? This remains to be seen as the Pfizer vaccination begins and the UK heralds itself as being the first in the world to begin a mass vaccination campaign to protect against COVID-19.

While taking part in scientific research and trials for vaccines has undoubtly opened new transnational ideas of curative citizenship (Rose, 2009), in the sense of acting for the common global good to find a cure, access to vaccines seems bound to citizenship and not to ideas of social justice, racial equity or biological or social needs. This is reinforced by therapeutic and vaccine hoarding that certain nations in the Global North have been engaging in. For example, Trump trying to gain exclusive access to a vaccine for the United States by buying up stocks for national interests (see Dyer, 2020), rather than fulfilling the potential and promises of collaborative academic and private-public partnerships for global equity, solidarity and rights to health (Forman and Kohler, 2020).

It's important to interrogate how this could have happened? While philanthropic organizations such as the Bill and Melinda Gates Foundation and the Wellcome Trust have been involved in setting up collaborative research platforms for cures and setting curative agendas for equity, the realities of pandemic preparedness mean that transnational partnerships can be quashed for national interests. This points to the need to interrogate how "cure" functions and for which political and economic interests. Philanthropic organizations have also paid less attention to the possible ramifications of the narrow development for cures without correlated investments in care and social equity. By way of illustration, what is the point of developing a cure for a neglected tropical disease, if you can still get seriously ill because the basics of healthcare are neglected (Berghs et al., 2020). Are there barriers in ethically interrogating or calling into account such inequalities in curative development? As such, this points to the importance of questioning definitions of cures, trajectories of their development and by whom curative agendas get set during pandemics.

A RESEARCH AGENDA?

To critically interrogate who gets cured, I argue that a new interdisciplinary research agenda is needed that builds on the theoretical tools that we have, to develop a medical sociology and anthropology of cure. Kavanagh and Broom (1998) emphasized that if you wanted to understand intersection between environmental and embodied risks, it was important to work together with people at "risk" to formulate new languages for changed norms and values, as well as approaches to novel environmental and socially embodied understandings. Similarly, a bioethics of cure could be an empirical-ethical theory that could develop from the experiential knowledge of patients with COVID-19 undergoing diagnosis, therapies and experiencing differing forms of cure (Caron-Flinterman et al., 2005) or undertaking differing forms of "curative labor" (Cooper and Waldby, 2014). Yet, we are all currently socially and culturally engaging with diverse materialities of cure in various settings.

There is an emotional and physical "curative labor" involved in gaining expertise on immunity or using techonologies to stay "well," keeping others healthy and negotiating curative risks of COVID-19 that we are all involved with. There are also people who will be identified as having more potentialities or probabilities to be cured and others that refuse cure. Likewise, many people are living in fear, shielding or bereaved and dealing with loss of curative hope and inequalities of cures. In a sociological sense, we have all gone through a biological disruption (Bury, 1982) and are dealing with the reality of "no cure" which has profoundly altered our worlds.

Hacking (2006) stated that people would socially organize around new types of genetic risks, but I argue that new forms of identity are emerging, not only in terms of pandemic risks and cures but concerning novel immunotherapeutic and curative risks of anti-microbial resistance, potentials and dashed hopes which are unsettling epistemologies and ontologies of how we understand biology, identity, embodiment and environment. We have the tools to socially frame this new world together with the people most affected, not only for the next pandemic but also with respect to novel developments in cure. We have to engage in interdisciplinary work with epidemiology, public

health, science and technology studies, economics, disability studies, psychology, politics, ethics, law and so on, to understand the impact of the search, development, potentials and realities of agendas for accelerated searches for cures and their impacts. We need to locate "cure" in pandemic preparedness but also wider scientific debates and biomedical and technological developments. What could "cure" now mean?

A NEW SOCIOLOGY AND ANTHROPOLOGY OF CURE SHOULD:

(1) Investigate how conceptions of cure politically change during pandemic responses and as a part of national and international agendas of technological innovation. Why does methodological nationalism but also the harsh policing of national borders, for instance, happen during acerated curative searches?;

(2) Critically examine and question the local and global inequalities in who gains access to care as cure and the (bio) ethical, social, financial, political, cultural and historical decisions that underpin such access. For example, who is going to gain first access to a vaccine globally and what are the underpinnings of such policy decisions? What is curative nationalism?;

(3) Understand the expectations, emotions, expertise and embodied experiences of what it means to undergo cure as patient, make sense of limitations of cure and/or lack of cure. For instance, how does it feel to survive COVID-19 and realize that recovery may only be partial? What psychological care and social support is needed?;

(4) Frame the local realities of cure against broader transnational activism and global debates linked to research for cures by focusing on how biological data is interpreted through kinship, gender, ethnicity and disability. What does it mean to be part of an accelerated search for a cure, such as a patient in a vaccine trial, and how do people understand their involvement and how their biological data will be used?;

(5) Map what needs exist for patients and their families, with respect to understanding new scientific developments linked to diagnostics, therapies, vaccines and cures. What information is needed by families who undergo latest curative interventions, such as gene editing or stem cell donations? How do they understand their curative trajectory and identity post-cure? Does a biopolitics of cure develop?;

(6) Chart what future impact a growing field of cures would have on health and social care services for patients where treatments are not an option, as well as disability activism and advocacy. How does cure become linked to time and notions of "normality"? Does a focus on cure lead to ableism in society and increase the imperative of health? Does this increase curative stigma?;

(7) Understand the norms and values of scientific involvement in diagnosis, therapies and vaccines for cures and if those are reflected by professionals working in development and financing of cures. Does a research scientist view their work as "curing"? Is that the same as the people who finance the cures or big philanthropic organizations?;

(8) Learn what impacts cures have when viewed alongside existing inequalities that affect patients in local and global contexts. Are there unintended impacts of cure? What role does artificial intelligence have in development of cures for patients or identification of patients who might need cures? How is accessibility to both testing for need of cure and cure itself ensured ethically, in for example, personalized medicine?;

(9) Investigate how information in a local perspective on cure connects to broader transnational and transgenerational debates to explore the ethical, economic, political, legal and historical implications of cures and searches for vaccines. Are new developments for cures connected to previous histories and pandemics, for example, Ebola? How do people make sense of those pasts in the present? Why don't we interrogate a logic of cure the same way we do care?

AUTHOR CONTRIBUTIONS

The author confirms being the sole contributor of this work and has approved it for publication.

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Stigma and Discrimination During COVID-19 Pandemic

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The COVID-19 pandemic has been instrumental in creating a dramatic shift from people's need to live in mutual association toward a desire to stigmatize distinctive others. Pandemic seems to be causing othering. Stated simply, stigmatization is a social process set to exclude those who are perceived to be a potential source of disease and may pose threat to the effective social living in the society. Based on the secondary evidence collected from news published online or in print, the present article delves into stigma associated with the COVID-19 pandemic among different social groups in the Indian society and the mounting cases of prejudice based on race, class, and religion. It also presents insights into the varied manifestations, and the deleterious consequences of COVID-19 inspired othering brought to its potential targets in India.

Keywords: COVID 19, stigma, stigmatization, discriminatory behaviors, victimization, social identity

INTRODUCTION

Humanity today is facing one of the biggest challenges of the century. The novel coronavirus is spreading rapidly to the extent of being declared as a pandemic across the world. The spread of the COVID-19 pandemic has raised concerns of everyone across the globe. People are in dismay for what is happening with them and at the same time are disturbed to see the conditions of others, particularly the marginalized. There is a sudden shift in people's daily routines. Apart from the fears, anxiety, and sadness, people's sense of irritability has started piling up. Amid such a deranged spread of COVID-19, one of the important concerns that is even more deleterious than all the above highlighted negative impacts and needs to be urgently attended to is stigmatization associated with the pandemic.

People have been witnessed to undergo a dramatic shift from their willingness to live in mutual association to an urge to practice stigmatization (1) of individuals, groups, and nations who are comprehended as potential sources of virus contagion to others. In other words, the pandemic seems to be causing othering (2), manifesting at the global as well as at the local context leading to a tremendous loss of social capital. The stigmatizing behaviors in the present context are being guided by the famous adage "better safe than sorry" (3) that explain that how the fear of something unknown and uncertain (4) accounts for the negative attitudinal reactions directed toward the people who are infected or are suspected and the ones considered responsible for the spread of the virus.

The present article takes a look at the increasing cases of "othering" that are characterizing the societal response at large. The focus will be on different social groups that are the targets of prejudice and discrimination so rampant during the COVID-19 crisis in India. It includes prejudice based on religion, occupation, race, and economic class.

THE PSYCHOLOGY OF STIGMA

The term *stigma* was first introduced by Goffman (5) to refer to visible characteristic features (such as cut of burnt) of the individuals that make the society devalue and consider them unfit for their inclusion in the mainstream society. Subsequent scholars have attempted to define the term from their unique perspectives (6) explaining the term with respect to relationship between mark and discrediting dispositions (7), a sociocultural-driven phenomenon (8), interwined in the nexus of power dynamics (9), which function to reinforce the preexisting power differentials (10–12).

The stigmatization phenomenon has been the intriguing areas of exploration pertaining to the specific context in which it unfolds. The evolutionary approach to stigmatization provides a convincing answer to the origin of stigmatization (8). Stigmatization is practiced as an adaptation (13) following a principle of discriminate sociality (14–16) in the perception of danger, threat, or challenges to one's social living, and attempts are made henceforth to safeguard oneself from various such foreseen or unforeseen impediments such as getting prone to infectious diseases, being advocated to the values contrary to their own, and having an intimidating out-group, etc. (8, 17, 18). The stigma of COVID-19, in the present context, could be comprehended as a social process that sets to exclude those who are perceived to be a potential source of disease and may pose threat to the effective social living in the society (13, 19).

Several theoretical approaches provide explanations to the phenomenon of stigmatization and the way it folds. In the following sections, we will try to explain the origin of stigmatization, theoretical approaches, highlighting the unfolding of the phenomenon, the purpose it serves for the stigmatized, and the effects the stigmatized reap out of their experiences of negative attitudinal reactions of the society toward them.

One of the earliest theories, the social interactionist theory of stigma (5), talks about the negative self-conceptualizations held by the stigmatized when they comprehend a discrepancy, during social interactions, between what the society expects them to be and what they truly are. As a result, the stigmatized experience shame for not being able to meet the expectations of the society and experience anxiety and fear of being rejected by the society.

The labeling theory by Becker (20) explains that people attach labels to others in order to ease their understanding of their social world around. The theory explains stigmatization as a phenomenon unfolding against those who are labeled as deviant based on their specific attributes or behaviors perceived as contrary to the acceptable standards in the particular sociocultural framework. As a result, stereotypes are attached to the deviant labels (5, 9, 21), and the targets become the recipients of negative psychosocial and emotional reactions of the society, hence stigmatized (22). The chances of stigmatization are direct functions of power and resources of the targets, level of tolerance for the deviance by the society, social distance between the two, and visibility of the deviance (23).

Another explanation for stigmatization comes from social identity theory (24, 25), which draws it from the self-categorization theory (Turner, 1979). According to this theory, self-concept of individuals draws heavily from their belongingness to social groups (25), which gives rise to intergroup comparison (26). Emphasizing upon the superiority of one's own group, a phenomenon called ethnocentrism (27), people set to positively evaluate and favor the members of their own group (in-group) and engage in derogatory attitudinal reactions (stigmatization) against the out-group for it reaps them benefits of elated sense of self-esteem.

As against the previous theories that talk about the explanations for the unfolding of stigmatization in a particular sociocultural context, the model of stigma-induced identity threat (28) highlights the reactions of the stigmatized on being exposed to the derogatory treatments of the society. In addition to experiencing stress, the reactions of the stigmatized are influenced by the way they appraise or evaluate the stigmatizing situations based on their collective representations (awareness about one's stigmatized status in the society, the dominant stereotypes associated, and the recognition of being discriminated against) (29), immediate situational cues (the characteristics of the presenting situation that could be perceived in terms of the amount of threat it brings to the social identity of the stigmatized) (30), and individual characteristics (the personal characteristics of the stigmatized that catalyze the influence of the stressful situations on the stigmatized, like the extent to which they identify themselves with their stigmatized group–(31)). Identity threat results when the situation is appraised by the stigmatized as harmful and exceeds the coping resources available with them to overcome it, resulting in several voluntary and involuntary reactions.

The process of stigmatization has several benefits for the stigmatizers (32) that serve to explain why people stigmatize others. Stigmatization not only helps perceivers to form a holistic and a simplified understanding of the targets (33–36), but also allows them to go beyond the available information about the targets and make judgments about their personality and behaviors (37). Stigmatizers strive to cultivate their biological and reproductive fitness through stigmatizing the diseased (19), dominating and exploiting others (11, 12), for example, which aids a successful transfer of genes to the offspring (38, 39).

Stigmatization also helps stigmatizers in maintaining inequality through power differentials (19), preserving important resources for themselves (8, 40, 41), such as wealth, power, and a reputed status (19), exploiting the stigmatized to serve their purpose (19, 42, 43) and emphasizing control over them by practicing derogatory behaviors against them (44). These practices serve to boost the self-esteem and well-being of the stigmatizers, as well as serve to reduce their existential anxiety [Terror management theory by (45)].

Several studies in the past have studied the negative attitudinal reactions of the society against the stigmatized in relation to a number of physical and psychological health problems, such as AIDS (46), mental illnesses (16, 47, 48), facial disfigurement (49), cancer, leprosy, and physical disfigurement (50), and in relation to various sociological factors, such as homelessness (51), sexual orientation (52), social class (53), caste (54), etc., where the

stigmatized become the passive recipients of negative emotional reactions from the powerful others (55).

Prejudices and discriminatory reactions against the stigmatized have also been the area of concern in the context of epidemics such as severe acute respiratory syndrome (SARS) (56) and H5N1 (57). Fear of contracting has been understood as one of the major precursors for the people to indulge in stigmatizing the infected (58) and the suspected because of their close-knit association with the spread of the disease [(56), p. 359]. Hatred is witnessed to be a common reaction of the society against the stigmatized during epidemics, particularly during modern times (59).

Although the stigma associated with pandemic has been a well-established phenomenon [(56), p. 359], due to its contextual nature (8, 13, 29, 60), the way it unfolds might vary depending on the context it finds its existence in.

The present ongoing situation of COVID-19 pandemic and its impact not only on the physical and psychological health but also on the way people are interacting with others are compelling enough to initiate analytical examination of stigma and discrimination related with COVID-19. This seems essential for the effective control of the disease, and the negative consequences of stigma aligned with being infected with coronavirus are extremely pernicious, the same way those were evident during SARS [(61), p. 729] and H5N1 outbreak (57). The psychological burden of such treatments strongly influences people's willingness to seek treatment or even let others know about (62). This not only impedes the process of effective management and minimization of the spread of the disease but also brings debilitating consequences for the overall well-being of the survivors and their relatives [(63), p. 108].

At this backdrop, using an analytical perspective, the present article delves into examining the way COVID-19–related stigmatization has unfolded itself against the specific sections of the Indian society and to gain a holistic understanding of the experiences of stigmatization as experienced by the people after the outbreak COVID-19 pandemic. An understanding of these would help us understand the way in which a crisis situation may lead to the segmented organization of the society in terms of strengthening of already existing categorizations, as well as emergence of new categorization. In addition, such an understanding is expected to supplement the government about the potential impediments that stigma is assumed to be creating in withholding the people's tendency of cause a delay in getting themselves tested or share their medical condition of being infected with coronavirus because of the fear of being stigmatized.

METHODS AND PROCEDURE

The present review is based on a careful review of literature on stigma during a pandemic and/or medical emergency and on the thematic analysis of news reports published online and/or in print editions since the outbreak of this pandemic in India. While the literature served as a vantage point to evaluate the social reactions of the current pandemic, the newspaper reports were treated as the sources of data related to the experience of stigma during COVID-19 pandemic. The news reports presenting negative reactions and/or experiences and the stigmatized treatments directed against people during the COVID-19 pandemic were thematically analyzed, and anecdotes were extracted to describe the stigma related to the dejection, derogation, devaluation, exclusion, discrimination, etc., associated with COVID-19.

STIGMA AND DISCRIMINATION IN INDIA: EMERGED THEMES

From the careful analysis of the content extracted through the newspaper reports, several themes emerged indicating the stigmatic expressions and behaviors during the pandemic. The following section discusses these emergent themes in the light of the available literature explaining stigmatization.

STIGMATIZATION OF THE SUSPECTED AND ACTUALLY INFECTED INDIVIDUALS

Since the outbreak of the pandemic in India, there existed a negative perception toward those infected with the disease. The COVID-19 patients are accused of being ignorant and negligent, thereby being held responsible for having contracted the virus (64). The COVID-19 patients were being stereotyped as the active spreaders of coronavirus and were being treated as the passive acquirers of the disease. Such a stereotype led the society to adopt several negative treatments (ranging from social media posts against them, stopping their entry into the residential areas, and spreading rumors against them on the basis of their religion, class, and caste) directed against them. Being an atypical condition, the devaluation associated with the mark of COVID-19 is indelible (19). Probably, that is why the consequences attached to its stigmatization are so devastating that even the formerly diagnosed continue to be stigmatized (65–67), and even after defeating the virus, they have not been able to free themselves from being shunned by society. They are reported being treated as untouchables, receiving the humiliating taunts, and fingers pointed against them and their family; their lane of residence has been named as "corona wali gali" (corona street), and the associated burden is strong enough that it has even compelled them to sell their own house (68). The fear among the people is so intense that it has led them to blame the scapegoats— especially the poor, laborers, daily wagers, and the migrants (69). Reports indicate that the people working in Delhi (India) and residing in Haryana (India) were negatively labeled as "corona carriers" by the Home Minister of Haryana, devaluing the former for the possible spread of the contagion (70). Even the doctors were not spared from being titled as the "carriers" of coronavirus (71). Therefore, not only the infected but even the suspected (due to the high risk of being infected) become the potential recipients of stigmatization (72).

There exists sufficient literature that highlights stigmatizing reactions of society against the infected during pandemics such as SARS outbreak [(56), p. 359] and shows that communicable

negative health conditions bear stigma (73). The stigma toward the infected or feared to be infected with COVID-19 could be explained by the terror management theory (45). Because of the lack of any medication or vaccine available for COVID-19 (74), a lot of terror has been evident among the people at large (75). This heightened existential anxiety among the people acknowledging the possibilities of their mortality due to contagion with coronavirus (76) seems instrumental in triggering set of defenses in the form of negative attitudinal reactions against those who threaten people's belief in their immortality (77, 78) i.e., the COVID-19 infected, their associates, and the suspects of it.

The evolutionary perspective (8) of stigmatization also sets to explain such negative treatments against the COVID-19 infected. According to this perspective, the stigma serves as the means to avoid and make distance from the coronavirus contagious individuals or groups (1) to safeguard themselves from catching the infection (6, p. 58). Such attitudinal reactions could also be understood in the light of labeling theory (20). Because the infected are labeled as different based on their unacceptable medical condition, they reap stigmatization from the society.

The notion of double stigmatization was also seen in some cases. A deaf-mute, for example, was deserted by his own family after they suspected him to be coronavirus positive that was later confirmed as not bearing the virus (79). Similarly, a coronavirus-negative deceased elderly was abandoned by the family suspecting the former as highly vulnerable to catch the virus (80).

THE STIGMA BASED ON RACE: THE CASE OF NORTHEAST INDIANS

The easternmost part of India, comprising eight states—Assam, Sikkim, Arunachal Pradesh, Manipur, Nagaland, Meghalaya, Mizoram, and Tripura—is known as Northeast India. The residents from the Northeast India have been the targets of racism from the mainlanders in India for a long time as they have typical mongoloid features, which are similar to the features of Chinese individuals (81). The people of Northeast India have mostly borne the brunt of racism and discrimination and have been often regarded as foreigners in their own country. The racism toward Northeast Indians have heightened during the COVID-19 pandemic, and many cases were reported (81) where Northeasterners were called "corona" spat at, socially avoided, asked to vacate their houses by their landlords, beaten, suspended from employment, or had difficulty in accessing health care (82, 83). These racial attacks and discrimination have also been evident in the prestigious educational institutions of the nation including Kirorimal College, affiliated to University of Delhi, Tata Institute of Social Sciences, Mumbai, as well as National Council for Educational Research and Training, Delhi (84).

Literature reports racism to be an important factor leading to an undue spread of disease in the minority community (85) even leading to their deaths (86). However, the experience of stigma by Northeastern individuals in India has mostly been due to their association and facial similarities with Chinese individuals who

are also stigmatized by many to be the reason for the origin of this pandemic.

THE STIGMA BASED ON PROFESSION: STATE OF HEALTH CARE PROFESSIONALS AND POLICE PERSONNEL

During this COVID-19 crisis worldwide, every country is trying to the best of its abilities and resources, to curb the spread of the pandemic. Individuals, groups, and communities are coming together and are presenting ultimate examples of prosocial behavior by helping those in need. Among them, there are doctors, nurses, other health care workers, police officers, and municipal workers who are risking their lives to serve their nation. India is no exception to this.

However, the doctors who are making arduous efforts to save the lives of the patients (87, 88) and the police officials who are working day and night, away from their families [(89–91)], are being ill-treated by the society (92, 93). They are fearful and are experiencing frustration arising out of their hard struggle and above all are facing social stigma (87, 94, 95) that does not even end with their death (96).

People at the forefront of the war against the pandemic (also called as coronavirus warriors) are becoming ostracized by their neighbors, landlords, taxi drivers, and even their own family members. Having left with no other option, doctors and nurses have had to sleep in the staff rooms and even in the washrooms of hospitals. Taxi drivers have also refused to serve them (97). The nurses have become homeless because of being shunned, attacked, and accused by their fearful landlords (87, 97) and have faced abusive and vulgar comments (98). Several cases of harassment (80), assaults, and false accusations of spreading the virus (99) have also surfaced against them. This has left them experiencing dismay (100), humiliation, and hurt, causing them to leave their homes (71).

Such ongoing stigmatized treatments directed against doctors, other health care workers, police officers, and municipal workers present classic representation of stigma by association (5, 101). Social stigma in this context becomes a function of disadvantageous alliances wherein even people who were not initially a part of the stigmatized group (doctors, nurses, and police) become the targets of stigma [because they are exposed the maximum to COVID infected patients; (102)].

THE STIGMA OVER THE DEATH

The social stigma of COVID-19 has not even shown mercy to the dead bodies of the patients. There have been violent disruptions or prohibitions of funeral ceremonies (80) and burials (103, 104) of COVID-related deaths. Fearful officials of Nigambodh Crematorium in Delhi refused to perform the last rites of the infected dead bodies because of the sheer lack of knowledge about how the virus spreads (105). People in Chennai opposed the cremation of a doctor and assaulted the medical staff on duty (96, 106, 107) for the same reason. Residents of village Verka,

Amritsar, had denied the cremation of Padam Shri Awardee and Hazoori Ragi, Mr. Nirmal Singh (108). Similarly, people in West Bengal protested against and condemned cremations of COVID-19 deaths at regular cremation places (109).

People's stigmatizing reactions for the dead family member indicate the strong and deep-seated embeddedness of irrational fear and threat that the virus has brought with itself. Several families in India denied claiming the dead body of their own kin members (110). Some have refused to do their last rites (111). Not even the ashes were collected by them, fearing the contagion; families forget about having their last glimpse before cremation (112).

Under such disturbing circumstances, many non-governmental organizations have taken the initiative of performing the last rites of the abandoned deceased. Abdul Bhai's Ekta Trust, for example, was accorded with the responsibility by the Surat Municipal Corporation, for the cremation and burial of COVID-19–infected bodies as per their respective religion (113).

THE STIGMA BASED ON RELIGIOUS IDENTITY: MARKAZ CONGREGATION

During March 13–15, 2020 a religious meeting (congregation) was held constituting of members of Tablighi Jamaat, an Islamic missionary and reformist organization (majorly of *Sunnis*-an Islamic subgroup), from all over the world at the Nizamuddin Markaz (Center) in Delhi. Later it was found that majority of these members were coronavirus-positive, and before they could be tested and contained, they returned back to their respective places all over India. The fear of the spread of the virus among general public was at the peak during that time, and the entire Muslim community at that time was stigmatized as the spreaders of the virus. The stigmatization of the whole Muslim community has been at the forefront of Indian public's reaction to COVID-19. Some political leaders were witnessed calling the Jamaat event as "corona terrorism" (114), and the congregation attendees as the "enemies of humanity" (115). Such reactions fueled the feelings of hatred and misplaced undue blame for the spread of the virus to this community.

In accordance with the dual model of impression formation (116) and the suppression justification model (117), holding a handful of Muslim Jamaatis' responsible for the spread of COVID-19 infections at augmented levels among the Indians could be contemplated as sufficient condition for cultivating the feeling of hatred and disgust for the whole Mohammedan community (114).

In accordance with the Social Identity theory (25), and Sumner's (27) conceptualization of ethnocentrism, the strong prejudices (118) exhibited against the social identity (119) of the Muslim community could be understood as a motivational act (120). Scheff (23) explains the level of tolerance for the target as a determining factor of the strength of the stigmatizing reactions directed against them. There has been a long history of Hindu-Muslim religious prejudice and discrimination reflecting less intergroup tolerance. The exaggerated negative reactions of society against the Muslim community could also be attributed

to the role of media (121, 122). Sensationalized and inaccurate reporting, like showing doctored videos of Jamaat members spitting on others (114), has contributed to public hysteria and widespread negative perception of the Muslim community. The consequence was the surge in hostility, segregation, and violence projected toward the whole Muslim community (123) and twitter hashtags saying "corona jihad" (114).

These acts have functioned to validate that Muslims' subvert position is well-deserved (54, 101) and have contributed to the entrenchment of the already existing gaps that exist between the religious groups in the society (10, 101, 124, 125).

STIGMA AGAINST THE MIGRANT WORKERS

A significant chunk of the Indian population migrates from their villages to different states and cities in search of employment and work largely in the unorganized/informal sector. When the nationwide lockdown was suddenly announced as a quick response measure to curb the pandemic, the country was neither prepared nor had foreseen the consequences the lockdown would have for the migrant workers, daily wagers, laborers, house helps, street vendors, barbers, plumbers, mechanics, and many more. The lockdown was perhaps the first step toward othering. It had an inbuilt bias toward the privileged when it was presumed that people could stay locked up in their homes and survive, without considering the fact that how would migrant workers and daily wagers survive even for a day without work with their hand-to-mouth existence. And within a week of lockdown, India witnessed and continued to witness over months one of the biggest humanitarian crises—the mass migration of millions of workers propelled by their socioeconomic hardships. The poor migrant workers were left with no choice, but to leave for their hometowns. The central and state governments had not envisioned this mass exodus. However, with the public transport system being shut, they were compelled to use other modes such as bicycle and even foot, for covering distances of over thousands of miles. There were many videos and photographs circulating on news media, highlighting the suffering of the poor—exhausted men, women, and children, walking empty stomach, carrying their belongings, with the sun glaringly over their heads (126, 127). It is humiliating to become a kind of refugee in one's own country and have negligible social security. As pointed out by Gupta (128), white-collar workers and students who returned home after lockdown from overseas as well as other Indian states were not labeled as "migrants"; the label was reserved to refer to people belonging to the lower socioeconomic strata whom Gupta (128) calls "collarless workers." The term "migrant" strategically paints a dehumanizing picture of these workers in mass media. Scheff (23) asserts that the chances of labeling specific kinds of people as deviant more than the others are the function of social distance between them and the society. This aptly explains the differential treatment poor received as compared to the white collar dominant others.

The stigma of being poor was highlighted when the government made arrangements for bringing back Indian

students, tourists, and others who were stranded in foreign countries, but paid little attention to the plight of these workers. Other incidents were when the migrant workers were sprayed down with disinfectant by health/civic departments on two occasions (129, 130). The act was not only unreasonable but also highly undignified, highlighting stigmatization to be the function of the social status of the people (131). It objectified the poor workers as contaminated with the virus. It also mirrored the racist treatment received by Latinos on the American border, who too were dehumanized in the exact same way a few decades earlier. The predicament of the migrant workers strongly suggests how fear-ridden powerful systems victimize and blame the helpless marginalized groups.

THE CONSEQUENCE OF STIGMA DUE TO COVID-19

The model of stigma-induced identity threat talks about the negative consequences stigmatization brings for the overall well-being of the people when they appraise the stigmatizing situations and identity threatening (28). The patients of COVID-19 are stigmatized and hence are bearing the consequences that are far more pernicious than the condition in its own self (1, 132). Social rejection has created a barricade between them and society (122) with repercussions for their physical, psychological health, and well-being (64). The patients are fearful of being shamed and stigmatized by society, extreme enough to exhibit the symptoms of hysteria (64). Some have also equated their distress to posttraumatic stress disorder (133).

The director of All India Institute of Medical Sciences, Delhi, warned about the perceived dread of being stigmatized among the people leading them to refrain from getting tested (134, 135). The social ostracism is responsible for people not seeking treatment or reporting symptoms and thus impeding an early detection of the virus and its effective control (62, 102, 122). The conditions are not even favorable for those who have tested negative for coronavirus. An individual in Madurai (136) and another one in Himachal Pradesh (**?**) committed suicide on facing social boycott even after being tested negative for coronavirus.

A recent survey (137) revealed that 61% of people in India are suffering from mental health concerns, with the percentage of women outweighing that of men. The deteriorated psychological health was mainly attributed to the lockdown and the associated difficulties (137). Among others, one of the significant concerns raised by the National Commission for Women is the rising quantum of domestic violence cases in India amid lockdown (71, 138). While lockdown and social distancing enforced by the government in the prevailing pandemic have contributed to an extent in curbing the spread of the virus, it has also contributed in the people experiencing depression (139, 140), anxiety, terror, panic, heart disease arising out of loneliness (140), and committing suicides (141). People are apprehensive about the possibilities of unknowingly carrying the coronavirus (142–144). All these ill effects of the pandemic when associated with

the rising stigmatization and discrimination are expected to have far-reaching consequences for the Indian society.

Other stressful concerns of people include witnessing the difficulties of the underprivileged and facing the economic crisis, increased frustration with other people, disordered regime, unpredictable future and the virus itself (145), maintaining physical distance, curtailed travel, and lack of or incorrect information (146).

INDIA'S REACTIONS AND MEASURES TO REDUCE STIGMA

Taking serious consideration of the entrenched stigma associated with the disease in Indian society, the Government of India has been taking active and cognizant measures to curb it. Particularly important is the launch of a caller tune, a public health communication strategy, and appealing to the general public to fight the coronavirus disease, not the diseased. The government has also tried to boost the self-esteem of the doctors, health care professionals, police, and hygiene staff by calling them "corona warriors" and encouraging the general public to pay tribute to the health care professionals. The entire country got together in clapping for the coronavirus warriors from their houses' balconies, they lit up candles outside their houses, and Indian fighter jets showered flowers on the hospitals housing COVID-19 patients. These measures played an important role in reducing stigma and fostering togetherness.

By the end of March, within 15 days of announcing the nationwide lockdown, the Indian Finance Minister, N. Sitharaman, announced INR 1.7 trillion relief package labeled the Pradhan Mantri Garib Kalyan Yojana. It was projected that under the scheme, 800 million Indians would receive 5 kg of wheat and rice for 3 months (in addition to the 5 kg they were already receiving). One kilogram of the preferred pulse was added to this distribution. Furthermore, 60 million farmers registered under the PM-KISAN scheme (who received INR 6,000 per year in three equal installments) were given the first installment upfront for the fiscal year starting April 2020. MNREGA workers' wages were increased from INR 182/— to INR 202/—. The government also provided relief for other marginalized groups, allocating INR 1,000 each for 30 million senior citizens, widows, and disabled Indians and INR 500 per month for 3 months to the 200 million women who were Jan Dhan account holders. Furthermore, women covered under the Ujwala scheme (83 million families) were allocated free LPG cylinders for 3 months. Over 2 crore construction workers received financial support totaling Rs 3,066 crore under the Building and Construction Workers' Fund.

All these actions were aimed at retroactively easing the crisis that was hurled at the Indian working class. At the fore of promising proactive measures to protect these workers is the effort spearheaded by the UP government. They have set up a Migration Commission for the employment of laborers in the state to ensure their social–legal–monetary rights. Any effort toward rehiring workers post lockdown would

now require states to seek UP government's permission and follow protective procedures that the commission would outline.

Apart from schemes aimed at helping the working class, the government also delayed the tax filing deadline under "Vivaad Se Vishwas Scheme" from March 31 to June 30, 2020, and expedited the income-tax refunds process, to release all refunds up to INR 0.5 million.

SUMMARY AND CONCLUSION

The above exposition clearly establishes the deep fissures that underlie the collective, which manifest in times of crises, such as a pandemic. It is rightly said that epidemics reveal who and what is genuinely valued in a society. The power hierarchies come to the fore. This article highlighted stigma associated with being an infected patient, or a close contact of someone infected, along with belonging to a particular race, religion, and social class. It is important to note that stigma reduces health-, help-, and treatment-seeking behavior and needs to be mitigated, apart from the focus on COVID-19 treatment and prevention. Global Health communication plays an important role in the construction of diseases, their social perception, and resulting psychological issues. Thus, all relevant stakeholders, including the government, media and local administrative bodies, as well as hospitals, ought to mitigate stigma through a multipronged approach. Logie and Turan (146) suggest that balancing measures of containment and prevention of the pandemic such as physical distancing and

travel restrictions, with appropriate information/public health messages and involvement of communities adversely affected by the pandemic (such as females, LGBTQI, marginalized races, poor), can help reduce the stigma.

Nature has made us all equal. It is us who create divisions in society for our own benefit. Stigmatization serves this purpose. But what it also does is create boundaries at the interpersonal, intergroup, and international levels that are often impossible to undo. There are those who actually commit crimes, and there are also several others who only reap the consequences of being associated with the negative, whether it be in terms of the nature of their work, shared social identity—family, religion—or as simple as being a scapegoat to the injustices that projected their way by the society. What is important to learn from all this is that it reflects a sheer loss of human ability to distinguish between the bad and good and the basic human essence of being kind and helpful toward others. And if this would continue, it is not going to serve any fruitful purpose in the long run for we all are humans first, and the association that we share with our family, religion, profession, socioeconomic status, and many more comes later.

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Face Masks During the COVID-19 Pandemic: A Simple Protection Tool With Many Meanings

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Wearing face masks is recommended as part of personal protective equipment and as a public health measure to prevent the spread of coronavirus disease 2019 (COVID-19) pandemic. Their use, however, is deeply connected to social and cultural practices and has acquired a variety of personal and social meanings. This article aims to identify the diversity of sociocultural, ethical, and political meanings attributed to face masks, how they might impact public health policies, and how they should be considered in health communication. In May 2020, we involved 29 experts of an interdisciplinary research network on health and society to provide their testimonies on the use of face masks in 20 European and 2 Asian countries (China and South Korea). They reflected on regulations in the corresponding jurisdictions as well as the personal and social aspects of face mask wearing. We analyzed those testimonies thematically, employing the method of qualitative descriptive analysis. The analysis framed the four dimensions of the societal and personal practices of wearing (or not wearing) face masks: individual perceptions of infection risk, personal interpretations of responsibility and solidarity, cultural traditions and religious imprinting, and the need of expressing self-identity. Our study points to the importance for an in-depth understanding of the cultural and sociopolitical considerations around the personal and social meaning of mask wearing in different contexts as a necessary prerequisite for the assessment of the effectiveness of face masks as a public health measure. Improving the personal and collective understanding of citizens' behaviors and attitudes appears essential for designing more effective health communications about COVID-19 pandemic or other global crises in the future.

To wear a face mask or not to wear a face mask?
Nowadays, this question has been analogous
to the famous line from Shakespeare's Hamlet:
"To be or not to be, that is the question."
This is a bit allegorical,
but certainly not far from the current circumstances
where a deadly virus is spreading amongst us... Vanja Kopilaš, Croatia.

Keywords: COVID-19, face mask, physical distancing, health communication, personal protecting equipment

INTRODUCTION

The coronavirus disease 2019 (COVID-19) pandemic is currently perceived as one of the greatest global threats, not only to public health and well-being, but also to global economic and social stability. While the first two decades of the third millennium were characterized by crisis—most notably the economic downturn of 2008 and the looming climate change—the spread of the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) virus originating from China has given rise to most drastic societal and political responses. These included measures as severe as states forbidding citizens from leaving their homes and effectively shutting down all social and economic activities (1). In Europe, Italy was the first country to officially detect the presence of COVID-19 in its territory, and it swiftly adopted measures to contain its spread (2–4). Within a few weeks, the epidemic progressively spread across Europe. Because of the novel situation and the contradictory opinions of experts, including representatives of the scientific community and World Health Organization (WHO), the level of threat caused by the disease appeared unclear (5). The assessment of the perceived risks of the disease varied in the public discourse—some considered it just as "a stronger influenza"; others drew parallels with the very deadly Spanish Flu outbreak in the 1918–1920, and many were simply not sure what to believe. Nevertheless, most felt the novel and unpleasant feeling of being vulnerable to the invisible threat of the infection (i.e., to be the ones in danger) or to be contagious themselves (i.e., to be the danger).

A variety of public health and hygiene measures have been initiated; the most visually noticeable perhaps is the wearing of face masks. The medical research on the use of face masks as personal protective equipment (PPE) against SARS-CoV-2 transmission was interpreted very cautiously, and the initial guidance from health officials was conflicting (6). The WHO advice was conceived to avoid unnecessary paternalism and at the same time be comprehensive in discussing different medical aspects of mask use. However, it was updated several times, shifting from initial statements that face masks are not to be worn by healthy individuals toward gradual adoption of face masks as useful in slowing community transmission. In particular, "…WHO has updated its guidance to advise that to prevent COVID-19 transmission effectively in areas of community transmission, governments should encourage the general public to wear masks in specific situations and settings

as part of a comprehensive approach to suppress SARS-CoV-2 transmission" (7). Gradually, face mask use has been recognized as a suitable measure within the scientific community (8–12), if nothing else due to the application of the "precautionary principle" in the face of an acute crisis (13, 14). This has since been backed up by empirical observations (15, 16).

Different, mandatory or voluntary, practices, and contradictory indications about the utility of face mask wearing were introduced across affected countries. Generally speaking, face masks have been adopted as one of the measures to reduce the COVID-19 spread across Europe, despite the fact that wearing masks in Europe is not common or familiar, and it is often associated with Asian countries (17). The social conventions and personal meanings of face mask use have received relatively little attention. Its use is deeply connected to social and cultural practices, as well as political, ethical, and health-related concerns, personal, and social meanings (18, 19).

In this study, our aim was to address three aspects of face mask wearing—public policies, individual behaviors and attitudes, and the collective experiences of the affected communities. In order to develop insights into the wider meanings of face mask wearing beyond (just) preventing the spread of infection, we tapped into the expertise of a scholarly interdisciplinary network, the Navigating Knowledge Landscapes—NKL (http://knowledge-landscapes.hiim.hr/), predominantly consisting of Europe-based scholars. The network is dedicated to furthering research on topics related to medicine, health, and society and comprises academics working across the disciplinary spectrum. We invited NKL members in May 2020 to provide their observations on the topic, also based on their professional experience. They were asked to describe the face mask usage in their countries and provide their subjective standpoints and/or those from their social environment. Subsequently, these testimonies within the specific time window (May 2020) containing narratives on face masks from the contributing experts were thematically analyzed using the method of qualitative descriptive analysis (20, 21).

MATERIALS AND METHODS

The invitation to write their views about face mask wearing was sent by e-mail to 97 experts, all members of the interdisciplinary research network Navigating Knowledge Landscapes (NKL; http://knowledge-landscapes.hiim.hr/). The invitation was sent on May 11, 2020, and the responses were collected until May 26,

2020 (over 16 days' period). The experts were asked to contribute a single-page narrative structured in four parts, framed as follows:

- Part 1: What are the rules adopted in your country about face mask wearing? What would be the overall approach for use of the face masks in your community (government instructions, availability, the citizen compliance)?
- Part 2: What is your individual/personal attitude and practice in relation to face masks? If applicable, start with good practice and end with what you consider to be mistakes.
- Part 3: How do you judge the behavior of people you encounter? Face masks (or no face masks) and interpersonal interactions. Again, start with positive and end with negative.
- Part 4 (optional): free to say whatever you think is important to the practices of your community in relation to face masks.

Twenty-nine scholars responded (30% of those invited), providing 27 contributions (two contributions were coauthored). They were from 22 countries, 20 from Europe (Albania, Austria, Bosnia and Herzegovina, Croatia, Czechia, Estonia, Hungary, Italy, Ireland, Norway, Poland, Portugal, Romania, Serbia, Slovenia, Spain, Sweden, Turkey, Ukraine, and United Kingdom) and two from Asia (China and South Korea). The contributors belonged to the following academic disciplines: biology (2), economics (1), engineering (2), information systems (1), law (1), medicine (6), philosophy (5), psychology (1), and sociology (10).

The contributors as experts are all highly educated (Ph.D., holders or Ph.D., students), and most of them are employed in academic institutions and perform research activities in their respective disciplines. The authors of this study were among the contributors.

The testimonials were based on the aforementioned open-ended questions and narrative in style. "Face mask" was used as the umbrella term for all types of face coverings, from the custom-made cotton scarves to disposable surgical masks and medical-grade N95 respirators. This was done to preserve the authenticity of these narratives without going into detail about the medical or microbiological features of the different types of face coverings. In the same way, grammatical or vocabulary use of non-native English speakers was kept as it was. The contributions received were collected and published as a citable open-source dataset at Mendeley Data repository (22).

The contributions were thematically analyzed by employing a qualitative descriptive approach (23). We chose this method because it aimed to provide "rich descriptions about a phenomenon, which little may be known about" [(23), p. 3] and was particularly useful for exploratory research such as our study. It is characterized by staying close to the empirical data, instead of seeking to provide a more conceptual interpretation of the phenomenon in question. Moreover, open-ended questions address different aspects of the same topic and allow formulating answers that could let respondents to frame face mask wearing according to their own personal views (24).

Concerning the thematic analysis, we divided testimonials in three categories. The first category captured the situation in the respondent's country; the subcategories we were interested in were the regulatory framework and the supply situation in each

respective country. The second category captured experts' own use of masks. Here we focused in particular on whether and in which situations they reported to wear (or not wear) masks, what kind of face covering they used, and the meaning they ascribed to masks (e.g., mask wearing as a symbol of social cohesion). Third, we categorized the participants' accounts regarding the practices and attitudes of mask wearing they observed in others. We created an MS Excel file in which we collected the respondents' statements on these different categories. In a subsequent step, we analyzed the data for patterns and recurring topics. We looked for country-specific differences and similarities in regulations and practices. Moreover, we also paid close attention to how the experts made sense of their experiences with mask wearing and how the issues addressed were expressed (e.g., experts referring to folk stories, metaphors, or past incidents). When presenting our research results, we focused on the topics we identified as prevalent through our inductive analysis, and we contextualized it based on the published research.

Ethics

The narratives analyzed in this study were given with the full consent of the people who wrote them and were made available for public access as an open-source repository for the research purpose (22). All the authors provided their consent that the narratives are published in the repository under their full name and affiliation and that they can be used for research purposes. The authors were cited here under their full names, recognizing their authorship of the narratives and their contribution to the dataset collection. The study received ethical approvals from the Ethical Committees of the University of Edinburgh, Scotland, UK and the University of Zagreb, Faculty of Croatian Studies, Croatia.

RESULTS

Face Mask Wearing From Medical to Public Settings

The use of a face mask—of various specifications according to the required degree of protection/function—is part of the PPE required in several professional activities, most noticeable in healthcare. One of the participants in this study, who works in healthcare, described her own experience in terms of the caring features of the face masks from medical to communal setting.

> "As an obstetrician–gynecologist, I am used with the mask, I feel it a part of my professional life, and I am trying to convince people that there is no way of considering the mask as an enemy but as a protection-like and umbrella against the rain, like a coat against the cold—and as a sign of civilization to protect our colleges and people around." [Iuliana Ceausu, Romania]

The contextual transfer of face mask use from healthcare settings to public spaces is precisely the aspect of making the "outside world" closely resemble scientific apparatus. This includes measuring its success as a feature of the social power derived from the accuracy of the scientific prediction. For

instance, Latour (25) specifically examines the public nature of Pasteur's demonstration of the efficacy of the process of animal vaccination by making a "prophecy" that vaccinated cattle on a pilot farm will survive, while other infected animals will perish. In the same way, the (anecdotally) apparent success of the use of face masks reinforces the belief in their utility and efficacy:

"The people working in the shops would use the masks too… I see familiar faces of the employees all the times of lockdown, although they spend all time in the shop with many different customers, obviously they did not get sick. This was for me a major reassuring fact that the danger is not so high as it could be seen from the media." [Srećko Gajović, Croatia]

It is worth remembering here the significant number of deaths of inadequately protected healthcare workers during the COVID-19 epidemic in various countries, mainly due to the lack of the appropriate PPE supplies (26).

The Politics of a Face Mask

Following initial confusion around the utility of face masks for slowing down the spread of COVID-19 pandemic, there is increasing scientific evidence to support citizens' wearing of face coverings, albeit the public health advice and legislation vary from country to country. A recent study in Germany indicated that a mandatory approach to face mask wearing achieved better compliance than voluntary one, and it was perceived as an effective, fair, and socially responsible measure (27).

In our study, accordingly, the reported country policies differed across rather a wide spectrum of approaches—ranging from legally mandated instructions to cover one's face in all public spaces reinforced by financial penalties (i.e., payable fines), to recommendations only, official indifference, or advice against this practice (**Table 1**). We were interested how these policies related to the concurrent COVID-19 situation expressed as total number and increase of cases per million people in these countries during the period when experts made their contributions. We observed an obvious trend showing that the countries with more strict rules had better epidemiological situation than those not mandating the face mask usage (**Table 1**).

In some countries, face mask–related policies did not need to be prescribed as this was part of existing established habits; in the same way, no fines are necessary to get people to wash their hands. In particular, since the SARS epidemic in 2003, in many Asian countries, masks are customary wear used to protect against seasonal flu and the common cold. In China and South Korea, they are also employed to protect citizens from pollutants (17, 29).

"In South Korea, it is common to wear a mask to keep the cold from getting worse in the winter and to prevent the spread of cold to others. Also, as the yellow dust from China and fine dust became much severe, it was common for many people, especially children, to wear masks even before the corona crisis. For this reason, many families even had a lot of masks in their homes before the corona crisis. Personally, I'm familiar with wearing a mask, and I'd like to wear it in order not to harm other people, as I may be a potential patient." [Jiwon Shim, South Korea]

In contrast, in the West, the use of face masks is rare in social settings. Hence, because of the public visibility of face mask usage, face masks became an ideological symbol in some countries, with divergent political mindsets governing their adaption or rejection (17). Political dividing lines were particularly apparent in the United States, where the President refused to wear a mask until the last days of July 2020, when the floundering poll numbers and the increasing numbers of COVID-19 cases prompted the need to recommend this health protection device (30). Thus, in the United States and elsewhere, face masks were used by citizens to express their opinions in public.

"At the beginning of the pandemic, the use of masks had political connotations: since the government advised against their use, their wearing was even considered a form of political opinion." [Iñigo de Miguel Beriain, Spain]

The public statement made by wearing (or not wearing) the face mask did not only address the political standpoints but have also been used to communicate various societally relevant statements, i.e., stating ethnical, religious, or cultural affiliations (31). For instance, many countries that before COVID-19 banned face coverings in public spaces are now mandating it, supporting the idea that the past bans were motivated on the basis of religious/cultural beliefs (17).

"Ethical and moral dilemmas have already risen, especially in countries where Muslim minorities live. If you ban a burka covering the face due to security reasons, how would you deal with massive usage of face masks?" [Gentian Vyshka, Albania]

"The decision to wear a face mask is not an easy one. Traditionally, face coverings are an indicator of political persuasion and religious belief. I perceive that the widespread covering of one's face in public is a significant cultural and social shift in Ireland." [Ciara Heavin, Ireland]

"To Wear a Face Mask, or Not to Wear a Face Mask, That Is the Question…"

The collected narratives indicated that the contributors had a clear standpoint on their own face mask usage and developed arguments to support their decisions to wear or not to wear face masks.

"As soon as I leave the house and find myself in the supermarket or in public places, I wear a mask. However, I do not wear a mask when I take a walk in the forest. I started wearing it even before it became mandatory. I think it is important to wear masks, especially to avoid endangering others, e.g., elderly people. I find it unspeakable when people who wear masks are ridiculed by those who do not wear masks. At least that's what happened to me in the beginning, before the mask duty… Many thought that the people wearing masks would want to protect themselves in particular. Very few thought that people wearing masks wanted to protect their social environment." [Melike Sahinol, Turkey]

"My personal view is that as long as the spread of the virus is under control (as it currently is), there is no need to make the masks obligatory. I personally have not worn a mask (have not purchased any either) with the exception of when I visited healthcare institution (provided by them). I must also say, though,

TABLE 1 | Perception of the official policies on face mask usage in May 2020.

	Obligatory ←————— Recommended No recommendations —————→ Not recommended	Total cases/million people	New cases/million people
Ying Long (China)	Wearing a mask is essential for the public to prevent COVID-19 virus	58	0
Mašić (Bosnia and Herzegovina)	Strictly requires face mask wearing, covering nose and mouth.	645	88
Bilyy (Ukraine)	A person to be in the "public place" without a mask was subject to a fine of 580–1,170 euros	348	138
Nasdyuk (Ukraine)	The obligation to wear a face mask… in public places		
Głos (Poland)	Wear a face mask in public (and) all open public spaces, such as streets, parks, boulevards, botanical gardens, etc., with the only exception being forests. Non-compliance is punishable by a fine of 500 zloty (about 125 euros).	423	149
Ceausu (Romania)	Wearing mask… among the principal preventive measures enforced	799	151
Vyshka (Albania)	Obligatory only indoor (inside institutions that still function or that are turning back to normality)	302	47
Mali (Slovenia)	Face masks and gloves mandatory in indoor public places (shops, etc.)	702	5
Šribar (Slovenia)	Determined as the obligatory means in the closed public spaces		
Lhotska (Czechia)	The use of face masks was obligatory anywhere outside home; currently, masks are mandatory in shops, public transport, and places where there is expected closer contact (<2 m) with more people	759	82
Pot & Prainsack (Austria)	Compulsory to cover one's mouth and nose with a mechanical barrier when entering indoor public places, as well as specific outdoor spaces such as open-air markets	1,753	74
Sahinol (Turkey)	Obligatory to wear masks when shopping or visiting public places	1,644	227
Martinelli (Italy)	Mandatory for entering in close spaces	3,623	184
Heavin (Ireland)	Citizens wear cloth face coverings in situations where it is difficult to practice social distancing	4,657	345
Buzas (Hungary)	Those who are not sick should not wear the simple mask as it does not protect against anything; from May 4, mandatory to wear the mask throughout the country while shopping and using public transport	340	50
De Miguel (Spain)	Masks are not necessary in Spain to go on the streets. From 20 April recommendation only as a complementary measure. From May 12, the possibility of forcing the population to use them	4,872	181
Machado (Portugal)	Recommended its use (surgical masks) to all health professionals, people with respiratory symptoms, and people entering and circulating in health institutions; on April 13, the compulsory use of face masks by all people staying indoors with multiple people and in public transportation	2,705	314
Shim (S. Korea)	It was common for many people, especially children, to wear masks even before the corona crisis	213	6
Gajović (Croatia)	The people using public transportation, both drivers and the passengers, are expected to wear the masks	533	14
Kopilaš (Croatia)	Our authorities have gone through a roller coaster of opinions ranging from not to wear a mask, to wear a mask, to the current state of mind where they encourage to wear a mask but ultimately leave it to each individual to decide for themselves		
Pale (Croatia)	There are recommendations and expectations, especially regarding public spaces		
Simm (Estonia)	Wearing of face masks has not been obligatory… but recommended for shopping and in public transportation	1,311	64
Todorović (Serbia)	The general public was instructed to wear facial masks only if they have symptoms of COVID-19	1,486	159
Webb & Ziebland (England, UK)	In all cases, the wearing of face masks or coverings is advised but not compulsory.	3,070	553
Vidmar (Scotland, UK)	"Face coverings" "may be of some benefit" if used by the public when in closed spaces		

(Continued)

TABLE 1 | Continued

Obligatory	Recommended No recommendations ← — — — — — — → Not recommended		Total cases/million people	New cases/million people
Svalastog (Norway)		Do not recommend a general use of masks	1,494	47
Olofsson (Sweden)		People are not obliged to wear face masks in public places	2,658	794

The official policies (in May 2020) on face mask wearing expressed by the participants in this study in their respective countries. They were distributed across the wide spectrum from mandatory connected with fines, to no recommendations to do so.

The experts' perceptions in the first two columns were associated to the numbers in the last two columns representing total cases per million people at the start of the study (May 11, 2020) and new cases per million people during the narrative collection period (May 11–26, 2020) in the corresponding countries (28). The numbers clustered as (green) <1,000 total or <100 new cases per million people, (yellow) between 1,000 and 2,000 total or 100 and 200 new cases per million people, and (red) more than 2,000 total and 200 new cases per million people.

It should be noted that the Table concentrated on the time period of the study as official advices, legislation, and numbers of cases subsequently changed during the course of pandemic.

that none of my family members are considered a vulnerable population. If my grandmother would live with us, I might think differently." [Kadri Simm, Estonia]

What was exemplified in many narratives is that individual usage is not meant predominantly for an individual's self-protection, but the decision was based on people's relationship to others. The citizens' question "should I protect myself" evolved into "can I protect the others?"

"I wear disposable masks, understanding they protect others from me, more than me from others. I wear them to demonstrate responsible behavior and attitude to benefit of society." [Predrag Pale, Croatia]

The experiences of interaction with others in relation to face mask wearing were mentioned frequently, indicating the importance of the social context of individual behavior.

"I experienced cases when my request to keep distance or to take on a mask properly was treated offensively or as a sign of mistrust…" [Christina Nasadyuk, Ukraine]

"I put it on when I go to the grocery store because at the early stage of the pandemic, I was warned by the lady working at the counter that I am putting her life 'in danger by not wearing a mask.' Obviously, I did not want to take chances with her life again, so I purchased one of those cloth masks." [Vanja Kopilaš, Croatia]

However, many testimonies pointed out that masks have not been used properly. The health risks of incorrectly wearing a face mask represent an important argument against the use of face masks as a public health measure (32).

"…25% wore masks improperly, on their necks, or covering only their mouths, but not noses. …They do not know how to put the mask on, and when they remove their masks, they touch the outside of the mask, which is inappropriate and wrong." [Izet Mašić, Bosnia and Herzegovina]

"Also, one can observe many cases of half-compliance or sham compliance. For instance, people do wear masks, but slide them

down onto their chins or take them off completely while talking to someone on the street or speaking on the phone. And this is all a performance, keeping their masks somewhere within reach in case of the sudden emergence of police officers, who are indeed issuing fines for not wearing a mask." [Aleksandra Głos, Poland]

This is even more complicated in situations when face masks were scarce (the stocks gradually improved through time in all examined locales).

"During the early stages of disease progression, mask wearing was not a common practice, mainly due to the complete absence and highly inflated prices in stores." [Rostyslav Bilyy, Ukraine]

"I do not use face mask. In the early stage of the COVID-19 epidemic in Norway, my understanding was that available masks should be reserved for people in the health and caring sector." [Anna Lydia Svalastog, Norway]

"I think the biggest concern is that the mask has been in short supply for a long time, and that its trade has not been subject to official pricing, so prices have been uncontrolled… The mask was in short supply when emergency was announced, but it is now available in many places and can be obtained at the checkout of almost every grocery store if someone started shopping without it." [Norbert Buzas, Hungary]

The shortage of masks ignited a burst of creativity in producing homemade masks, with a proliferation of tutorials for their production on the Internet and social media.

"Nowhere was possible to come to the face masks. Typical situation: the government did announce decree, but it did not provide the means for its implementation. We as ordinary citizens need to improvise with needlework of masks at home as well. Taking in regard that immediately rapacious war profiteers did appear by selling masks the needlework of masks at home was even not the worst solution." [Franc Mali, Slovenia]

"Although during the first weeks there was lack of masks and respirators, it was great how many people proved their creativity. It concerned not only the textile reusable masks, but also design and development of respirators with higher level of protection. They

were mostly printed on 3D printers. Later on, some of the approved types were taken by larger producers, and mass production started." [Lenka Lhotska, Czechia]

Mask Wearing at the Interface of Personal and Social Responsibility

Besides being shaped by public discourse and social norms, risk perception also has a strong personal element. Some people seem like they do not care; others are quite relaxed, and some are more cautious. As for COVID-19, conflicting perspectives and emotions and even the psychological entrapment syndrome known as "cabin fever" (i.e., referencing long winter isolation in a small cabin) have been reported (33). Here, restricted microenvironments and quarantine are felt as secure places. The additional challenges were noticeable during the shift from the lockdown phase and the beginning of the so-called "phase 2" or "reopening" when people were allowed to leave their home again.

"'Convivere,' i.e., 'live together with' the virus is the expression used by experts and media, to describe the phase 2, but this narrative could result quite distressing: how glad would someone be when living with a submicroscopic entity, that is such dangerous?" [Lucia Martinelli, Italy]

During this second phase, going back to living with "the others" demands new social behavior/etiquette combined with increased safety measures. The face masks start to be part of the new everyday rituals of saying hello, having a coffee together, and protecting each other. The role of peers in shaping the behavior of others is significant. People not committed to wearing mask can feel peers' pressure to comply. Moreover, "a collapse between the status of *being at risk* and *being a risk*" was noted (34–36).

"The face mask, I realize, signals both positions, at the same time as it doesn't provide a definite answer: are you the risk object or the object at risk? Saying this, my individual attitude toward face masks cannot be pried apart from the social acceptance and use of the same. As long as the nonuse of face masks constitutes the norm, I will most likely interpret the usage as deviant and worrying. On the other hand, if the vast majority of the Swedish population would wear face masks, I would most likely start wearing a face mask as well. Here, the mass effect kicks in." [Jennie Olofsson, Sweden]

"The massive use of the masks among Albanian citizens… has become a normal well-adopted ritual of surviving, implemented as of a social significance for 'not letting the virus in.' This social cohesion on the intrapersonal view as 'to scare the virus" and 'fear of an enemy' comes close to a group approach of 'control and stability.' This ritual of social cohesion vis-à-vis the 'fear of death' or 'fear of the unknowing' is a similar to a psychological regression, when the individual survival depended largely from the herd." [Gentian Vyshka, Albania]

"For me, unlike other measures to contain the spread of the virus, the wearing of masks is predominantly a symbol of social cohesion and complying with the rules and not so much a measure to effectively protect myself and others from infection. The few times I saw someone without a mask entering a supermarket or the metro, my first thoughts were about social deviance and the arrogance of ignoring a commonly agreed-upon practice, and not about the risk of infection." [Mirjam Pot & Barbara Prainsack, Austria]

Individual and collective responsibility and trust in the institutions and in the official assessment of risks and recommendations as to the adopted measures are crucial to build up a degree of epistemic agreement (37). However, this is perhaps more challenging in a contested environment of "recommendation trust" (38), which likely depends on communicating certainty (39), of which very little has been seen during COVID-19 pandemic. Hence, the acceptance of official advice varied among countries, cultures, and political contexts, with some degree of contradiction.

"In general, there seems to be a relatively wide acceptance of government recommendations, but a very patchy uptake. Though the Scottish Government advice is trusted more than that from the UK Government, significant generational and cultural differences can be seen as to its implementation… in a multicultural society such as Scotland, there are some subtle differences between people from different cultural backgrounds and traditions who are either more accustomed to follow stricter government instructions, or from cultures where face mask wearing is more commonplace." [Matjaž Vidmar, Scotland, UK]

"Finally, as an anecdote, I would mention the recent case of expelling an opposition MP from the Assembly because he did not have a mask on his face, although the Prime Minister who warned the MP did not have a mask either." [Zoran Todorović, Serbia]

The pandemic also seems to have reminded many people about the responsibility of humanity toward the preservation of all the living organisms and, as recognized by the Centers for Disease Control and Prevention (40), that our health is closely connected to the health of whole environment.

"We should see ourselves as the most important participants and the biggest beneficiaries of public health, so we should take expert advice—wear mask. In other word, under this special situation, we need to work with medical experts, government to co-build a safe, harmonious and orderly living world with 'One Health' concept, rather to resist or despise it." [Bie Ying Long, China]

The Face Mask: A New Barrier Affecting Social Relations?

If we assume that in the near future we will be used to living with the pandemic, or even a series of pandemics, we are currently developing new norms for social interaction. Being with other people and enjoying their company are essential for our mental and physical well-being. How do these interactions include face mask usage? What will socializing look like in the era of physical distancing (i.e., "keeping a safe space between yourself and other people who are not from your household") (41)? These issues are being recognized as particularly challenging.

"We must reinforce the message that face masks do not remove (or even reduce) the need for social distancing as well as excellent hand and respiratory hygiene. We need to avoid a situation where face masks become a weapon that could negatively impact our fight against this invisible enemy." [Ciara Heavin, Ireland]

"I believe the benefits of face masks may be overestimated and lead us into a false sense of security in which we take unwarranted

risks—such as touching more objects and neglecting handwashing or going outside when suffering from a cough or cold. Therefore, my preference would be to give greater attention to other steps such as providing screens and visors for workers in public facing roles and reinforcing protective mechanisms around social distancing." [Helena Webb & Sue Ziebland, England, UK]

"Since the use of a mask started to become widespread, people seem to feel safer and unfortunately are more at risk, for example, not maintaining physical distance, making appointments with extended family and friends, etc." [Helena Machado, Portugal]

Not all evidence is in support of above assessments that face masks bring about a (false) sense of security. In a recent study conducted in the Italian Venice metropolitan area, wearing a mask has proven to be a visual factor strengthening physical distancing as a public health measure (3). Between February 24 and April 29, 2020, distances have been measured by an operator wearing an exclusive sensor-based "social distancing belt." They were interchangeably "unmasked," "masked," "do it yourself (DIY)-masked," "goggles masked," and "goggles DIY-masked." Results show that people tended to stay closer to an unmasked person, while mask wearing tended to increase the physical distance. This paradox is explained by considering humans' intrinsic social nature that favors social vs. antisocial behaviors (3). Wearing a mask thus can turn unconscious social behavior into conscious antisocial behavior.

"I believe that due to the extraordinarity of wearing face coverings in public spaces in Scotland, these do not encourage an undue feeling of 'safety' by their use, rather the reverse. Hence, with full awareness that the evidence for being protected by this measure is not there, rather, I hope that by wearing a face covering, I may remind (or even deter) others from breaking social distancing rules." [Matjaž Vidmar, Scotland, UK]

Marchiori's study (3) also suggests that distance increases with face mask wearing, thus supporting the importance of visual stimuli as a signal of danger. This fact recalled in the mind of our colleague, Bie Ying Long, the ancient Chinese tale of "The Blind Man Who Lights a Lantern While He Walks in the Night," which proposes a "wise" interpretation of action as interplay of altruism and self-interest (42). When people asked a blind man for the reason why was he carrying a large lantern when he traveled at night, he replied that while day and night were not different to him, carrying a lantern while walking in the night was for the sake of everyone. For him, the lantern provided protection from other people, allowing them to avoid bumping into him. For others, carrying a lantern shone a light on them and let them walk more securely.

"In the present, we should learn the kind of survival wisdom of the blind man in the story. To wear a mask proactively does not mean 'I'm infected with the virus,' rather to protect my own health. At the same time, it is a reminder to others that we are still in a time of crisis; we need to pay highly attention to our health and life safety very seriously." [Bie Ying Long, China]

However, face mask use may have adverse systemic effects, as well:

"The use of a mask is seen as an act of responsibility and altruism. However, I notice that people with masks tend to avoid personal interaction and to decrease the time they talk to each other. They avoid looking at others." [Helena Machado, Portugal]

"The syntagm social distancing is problematic because it symbolically transforms the rule of physical distance into the subversion or deconstruing of social ties. Face masks are strongly related to this implicated meaning. The human estrangement as a part of the 'COVID-19 regime' is the reason I have been more annoyed by some people strongly emphasizing the need for masks and physical distance than by those exhibiting the lack of interest for the personal protection against the infection." [Renata Šribar, Slovenia]

In this framework, institutional health communication plays a crucial role in motivating citizens to wear face masks and use them properly (i.e., how to handle it and how to cover one's mouth and nose), as well as to respect physical distancing and hygiene procedures. Here, the choices of narratives by public health system officials play a crucial role. Accordingly, the expression "social distance" tends to be avoided nowadays. "Physical distancing" has been adopted by the WHO, which they define as keeping a distance and avoiding spending time in crowded places or in groups (43). More distressing expressions such as "avoiding all unnecessary contacts" and "unnecessary contacts with the others" are used in some official advices (44). These messages may appear authoritarian, by intruding in the personal space of what is "unnecessary" and about who are "the others" when considering social contacts and human relations.

Conversely, an interesting example for motivating the correct use of face masks is the communication campaign "Per tornare tutti insieme a sorridere" [To get back to smiling together] by the Italian Health Ministry (45). This message designed to stimulate feelings of mutual protection and solidarity among relatives, as well as among strangers. Motivation is crucial because, as we have demonstrated, a face mask can be perceived as both a physical and psychological barrier, particularly in countries where covering one's face is not a common habit.

Wearing a face mask, in fact, makes it hard to recognize if someone is smiling at you and to acknowledge non-verbal communication and emotions shared with facial expressions. This limitation has been noticed in the interactions with older, fragile, and cognitively impaired persons/patients, communication with whom strongly relies on body language (46). Not only in these contexts, but also in relation to day-to-day activities, especially with strangers, new communication skills are necessary, such as direct eye contact (47) and body gestures. Moreover, to communicate with those with hearing loss, special transparent masks have been proposed (48). As the fear of infection makes us more distrustful of strangers and even of friends and family members, to achieve the social interaction we were used to before the pandemic, a new demonstration of care and affection should be conceived.

"When I walk and nobody is around me, I do not have my mask on the mouth and nose; however, when I'm approaching people, I pose it in the proper way and smile (with my eyes): I consider this a sort of 'greetings and courtesy nod,' a way to say 'I care for your health, do not be afraid by me, we will help each other.' I consider it as a message of solidarity." [Lucia Martinelli, Italy]

DISCUSSION

Although a "simple" face mask may not be considered in or of itself a sophisticated technological artifact, its systemic use in healthcare settings, its past adopted use in certain social contexts, and the current significant expansion of its application to public health measures (as evidenced through the testimonies and literature outlined above), it can be understood as a facet of a substantial technoscientific project. Importantly, face mask use in the case of COVID-19 has an obvious medical/healthcare connotation, even though face masks are used in many professions to protect the workers against inhaling dust or harmful substances. In fact, many mask types worn during the pandemic come from non-medical supplies (the standard "filtering face-piece" or FFP1 and FFP2 models). However, it is the medical-grade masks that serve as a reference point for all other (varieties of) face coverings.

Face mask wearing can be conceived within the practice of extending the medical science into the "outside world," by making the behaviors and rituals of the society/culture more alike the scientific (laboratory) practices (25). The ideological repertoires used in doing so, however, depend critically on cultural differences among societies being thus transformed, and understanding them can help contextualize the political and social dimensions of implementing this public health measure. Such understanding can also serve as a resource for the introduction of other measures, as well as the uptake of face mask wearing in environments where it has not yet been adopted. In short, face masks are being recognized as boundary objects mediating between different individual and collective ideologies (31) and are as such artifacts with distinct politics (49).

The aim of this exploratory study was to understand face mask wearing in terms of public policies, individual behaviors and attitudes, and the collective experiences of the affected communities. The main results of our study highlight that the societal and personal practices of wearing (or not wearing) face masks are influenced by (1) individual perceptions of infection risk, (2) personal interpretations of responsibility and solidarity, (3) cultural traditions and religious imprinting, and (4) the need of expressing self-identity.

First, even for individuals who might not be concerned for their personal health and safety, the wearing of a face mask often indicates a level of care and respect toward others. The decision about wearing a face mask is mediated by standpoints on utility of face masks based on scientific knowledge and/or in the absence of scientific consensus also on political beliefs (17).

Second, the behaviors of others were described in the collected testimonies in terms of societal responsibilities and rituals of social interaction, highlighting the role of peers in shaping the individual behavior. The narratives shine a light on the perceived

balance between protecting oneself and social responsibility, reasserting the notion "If the people wearing masks are protecting you, isn't it right that you should protect them in return?" (17). However, this leads to inherent contradictions in the behavioral change required. The interchangeability of *being at risk* and *being a risk* is particularly striking (34–36), making face mask wearing both an act of self-interest as well as altruism (42). In a similar vein, what could be perceived previously as anti-sociable behavior may now be beneficial for societal well-being (protection against the pandemic) and, in fact, preferred (3).

Third, our analysis highlighted that many countries, specifically those in Europe, that previously banned face coverings in public spaces are now mandating them. Face mask wearing has enjoyed varying levels of acceptance across different cultural, governmental, and religious environments; however, even in our study, we could show that the strict rules correspond to the better epidemiological situation (50). Moreover, the voluntary policy and insufficient compliance can be perceived as less fair allowing individuals to compromise epidemiological measures, while a mandatory policy appears as an effective, fair, and socially responsible (27). Although the mask can become a symbol of the fight against the virus or of neglect, it remains controversial who and when should have the control on the use of the symbol (51).

Fourth, the use of face masks preventing the spread of the virus is complemented or even upgraded by the use of face mask as a visual communication tool during times of lockdown and isolation providing a new way to communicate during a pandemic. This covers both political statements in relation to states' public health measures, as well as personal expression of raising awareness, collective solidarity, or just as a part of new pandemic-related esthetic.

We hope that this research will help develop new frameworks to guide a more holistic approach to understanding and enabling behavioral change among citizens, as well as enabling new models for non-verbal communication, noting specific challenges such as disability (46, 48). Recent articles highlight the need to develop new ways to communicate while wearing face masks through body language, particularly in terms of using eye contact to communicate emotion (52, 53). Also, there is an opportunity to develop new ethical frameworks to guide collective and individual decision making around face coverings. For health policy makers, our study highlights that public messaging plays a crucial role in institutional health communication and that in-depth knowledge of various cultures and ethics concerning health habits are relevant to informing and developing reliable information resources and policies for citizens during a global health pandemic.

However, this study was not without limitations. We acknowledge that our sample is yet representative of a group of intellectuals with a higher level of education, and therefore, the data cannot be generalized to the whole society. The methods we applied for data collection and analysis, however, fit the aim of our research: to explore the broad range of personal and social meanings of mask wearing in different countries. Furthermore, our sample combines the professional and personal observations by health and other experts providing a unique

interdisciplinary perspective on face masks. Although we asked standard questions, we let people answer them in freestyle. We did not ask our authors to alter, explain, or correct their narratives in any way.

As shown by the narratives, during the COVID-19 crisis, inconsistent information may influence citizens' level of perceived risk, thus resulting in excessive fear or denial of the reality of the pandemic (54). The credibility and the source of the information may be crucial to promoting citizen compliance and best practice of face mask wearing. Here, the need to better communicate the complexities of (un)certainty (39) may be a useful lesson for public health officials and experts building "recommendation trust" in their advice (38).

From a purely medical perspective, the effectiveness of measures to contain the spread of the virus is independent of the geographic area where these measures are implemented. From a social scientific perspective, however, individual and public health is always embedded, in particular social, cultural, and political contexts. Because of these influencing factors, health measures and devices are imbued with particular meanings that differ across countries. The specific meaning of a device, such as a mask, acquires also shapes how people deal with it and how they integrate it (or not) into their everyday routines and practices (55). Ultimately, this implies that studying the personal and social meaning of mask wearing in different contexts is also necessary for the assessment of the effectiveness of face masks as a public health measure.

In conclusion, our study points out the need of an in-depth understanding of the various social, cultural, religious, and ethical considerations on health habits and attitudes in a time of pandemics. Additional knowledge about the variety of personal and collective understanding of face mask wearing is essential for designing more effective health communication during and beyond the COVID-19 pandemic.

DATA AVAILABILITY STATEMENT

The datasets presented in this study can be found in online repositories. The names of the repository/repositories and accession number(s) can be found below: http://dx.doi.org/10.17632/9s6fm7vdbc.1 (22).

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Ethical Committees of the University of Edinburgh, Scotland, UK and the University of Zagreb, Faculty of Croatian Studies, Croatia. The patients/participants provided their written informed consent to participate in this study. Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

AUTHOR CONTRIBUTIONS

LM, VK, SG, CH, HM, NB, MP, and BP: designed the study. LM, VK, and SG: performed data acquisition, organization and analysis and wrote the first version of the manuscript. VK, MV, CH, HM, ZT, NB, MP, and BP: contributed to the interpretation of the results and critically revised manuscript. All authors approved the submission to the journal.

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How Does Public Knowledge, Attitudes, and Behaviors Correlate in Relation to COVID-19? A Community-Based Cross-Sectional Study in Nepal

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Background: The COVID-19 pandemic has created a global health emergency requiring an effective public health response including citizen's roles in preventing spread and controlling the pandemic. Little is known about public knowledge, beliefs and behaviors in-relation to the pandemic in Nepal. This study aims to assess knowledge, attitude and practices (KAP) toward COVID-19 among the general public and to identify associated factors.

Methods: A cross-sectional survey was conducted between May–June 2020 with a sample of 645, recruited from 26 hospitals across Nepal. We conducted telephone interviews using a semi-structured questionnaire related to KAP regarding COVID-19. T-test and one-way ANOVA was conducted to determine group differences for socio-demographic variables. Linear regression and correlational analysis were performed to identify associated factors and measure strength and direction of relationships.

Results: Overall mean scores for knowledge, attitude and practice were 11.6 (SD 4.5), 2.7 (SD 1.8), and 9.9 (SD 1.93) respectively, but differed by socio-demographic characteristics. Positive but weak linear correlations were observed between knowledge-practice ($r = 0.19$, $p < 0.01$) and attitude-practice ($r = 0.08$, $p < 0.05$). The relationship between knowledge and education was fairly strong ($r = 0.34$, $p < 0.01$). Province, place of residence, ecological area, age, gender and caste/ethnicity were also significantly associated with KAP score of participants.

Conclusion: The study found varying degrees of correlation between Knowledge, Attitude and Practice that may increase as the pandemic evolves in Nepal. Knowledge and level of education had positive associations with attitude and adherence to precautionary measures. The findings suggest a need for targeted community awareness interventions for the most vulnerable populations, men, those with no school education, the elderly and people living in rural areas.

Keywords: COVID-19, knowledge, attitude, practice, correlates, Nepal

BACKGROUND

The World Health Organization (WHO) declared COVID-19 to be a public health emergency on 30th January 2020, after a month of the Corona virus outbreak in Wuhan, China (1). Nepal detected the first case of Corona virus infection on 23rd January that surged to 11,700 affecting all 77 districts with a total 28 reported deaths by the end of June 2020 (2–4). Measures including a country-wide lock down have been adopted to prevent transmission, however the disease continues to spread.

Prevention and case-management during pandemics requires public support together with government action. The effectiveness of actions and control measures depends on the extent to which people change their behavior. The health belief theory explains that a person is likely to take health actions if the individual believes that s/he is susceptible to the disease or would have serious effect upon him if contracted. Further, if a person is aware about certain actions that can be taken and believe that these actions may reduce his likelihood of contracting or reduce the severity of disease (5). Literature informs that individual beliefs and perceptions play an important role in subsequent behavioral change (6). Studies conducted during the SARS outbreak in 2003 found individual beliefs and perceptions to be an important factor in subsequent behavior change (7). Moreover, that the higher the perceived effectiveness of measures, the higher the chances of action being undertaken. Likewise, higher perceived threats of the disease lead to higher rates of behavioral change (8).

Having a well-informed public about the COVID-19 virus, it's causes and mode of transmission, could be one of the best strategies to prevent and slow transmission. However, until recently there was limited information and scientific knowledge about the virus. Scientific understanding about mutation rate, transmission, disease symptoms and severity, herd immunity and risk groups is still emerging and this uncertainty creates a challenge for reliably informing the public, resulting in confusion about the best practices for health protection and negative impacts on mental health (9). Under such conditions, designing effective and contextually appropriate interventions to support risk reduction and behavior change is demanding.

There is an urgent need to understand public knowledge about COVID-19, their beliefs and behaviors, in order to produce information that facilitates effective public health responses. This study aimed to assess the knowledge, attitude and practice toward COVID-19 among the Nepali population and identify any relationships between KAP scores and demographic factors.

METHODOLOGY

Study Design and Population

A cross-sectional survey among attendants to fever clinics in hospitals was conducted between May 17 and June 9, 2020.

Participants' Recruitment Procedure

A multi-stage sampling method was used for recruitment of participants. The study covered all seven provinces, with participants drawn from 26 health facilities, from 23 out of 77 districts covering both ecological zones – hills and Terai. A sampling frame was developed collecting the names of those who attended fever clinics between April 25 and May 16, 2020 in the selected health facilities. Out of 1,285 fever clinic attendants, 687 met the eligibility criteria for the study and were included in the study. Individuals aged 18 and above, who visited hospital suspecting or having COVID-19 symptoms were the inclusion criteria.

Survey Instrument and Data Collection Procedure

A semi-structured questionnaire seeking socio-demographic information and knowledge, attitudes and practices (KAP) regarding COVID-19 was developed and administered. The socio-demographic information included participant's age, gender, education, occupation, caste and ethnicity, religion and marital status. The living area (province), ecological zone and place of residence (urban or rural) were included. The second section of the questionnaire consisted of knowledge about COVID-19, attitudes and practices regarding COVID-19. Based on the published literature, WHO and local government's information and guidelines (10–12) for COVID-19, 27-items of knowledge, 3-items of attitude and 4-items of practice related questions were adapted.

The standardized questionnaire was set up on tablet computers and mobile phones with KoBo Collect software and administered in Nepali through telephone interviews by trained data collectors. The questionnaire was first developed in English, translated into Nepali by three bilingual Nepalese and field-tested for acceptability and comprehension among the population in which it was to be used. On average, administration of the questionnaire took 24 min.

The research obtained ethical approval from the Nepal Health Research Council (NHRC) - ERB Protocol Registration No. 317/2020P. Before interviews, verbal informed consent was taken from all participants.

Measures

The KAP indicators were created by questionnaire items to derive scores. The knowledge questionnaire consisted of 9 items about COVID-19 symptoms, 2 items about risk, and 8 items each about transmission and prevention. Knowledge in those questions was spontaneously cited and presented as an additive score. All the questionnaire items were equally weighted, dichotomized, and score was created using the sum with the maximum scores of 27. The attitude score was developed using a 3-item questionnaire about the individual beliefs on remaining safe from COVID-19, beliefs on easy availability of healthcare services, and belief on government's ability to control the current pandemic. Similarly, the practice questionnaire included questions about social distancing, use of masks, hand washing and use of hand sanitizer. The two practice questions had two rating scales while all the other attitude and practice items consisted of four rating scales with the score weight ranging 0–3 making a maximum total score of 6 and 12 for attitude and practice, respectively. In this study it is interpreted that the higher the attitude score, the higher the pessimistic attitude or perceived risk. Chronbach's

Alpha coefficient of the knowledge and attitude questionnaires were calculated 0.78 and 0.71, respectively, indicating acceptable internal consistency (13).

Statistical Analysis

This study analyzed the data using SPSS (version 23.0 for Windows). We used the descriptive and inferential statistics. The categorical variables were summarized using frequency and percentage, and the continuous variables using mean and standard deviation (SD). Independent sample t-test and one-way analysis of variance (ANOVA) were conducted to determine the differences between groups for selected socio-demographic variables, while bivariate correlation analysis was performed to measure the strength and direction of relationship. The relationships between knowledge, attitudes and practice scores were examined using bivariate correlational analyses and multivariate linear regression models. We conducted linear regression analysis using knowledge, attitude and the demographic variables as independent variables and practice score as the outcome variable to identify factors associated with practice.

RESULTS

Characteristics of Study Participants

The response rate in this study was 84%. Out of 687 people approached for interview, 6% refused and 645 participants were interviewed. Twenty-seven interviews were excluded from analysis due to incomplete information and a total of 618 were included in the analysis. The highest proportion of participants (17.8%) were from Karnali (Province 6) and the lowest from Province 5. The majority of study participants (79%) lived in urban area, while 63.6% in the hills. The average age of the participants was 35 years ranging 18–85 (SD = 14.25). More than one-third (37%) were women, majority of the participants (55%) reported having their secondary level education and 16% with higher education. Nearly 4 in 10 reported their occupation as labor and 16.8% having foreign employment. Just under 43% participants reported their caste group as Brahmin/Chhetri and over 17% as Dalits, and 77% were married (**Table 1**).

Knowledge of COVID-19

The study found COVID-19 knowledge mean score at 11.6 (SD 4.5; range 0–27) suggesting an overall knowledge score rate at 43%. Knowledge score significantly differed among the participants by province, residence area, age, gender, education, occupation and marital status. Province 5 respondents had highest rate of knowledge score (mean 12.8; SD 5.6) followed by Gandaki (mean: 12.4, SD 4.6) and Province 2 (mean: 12.4, SD 5.0), while Karnali people had the least (mean: 10.4, SD 4.4). Urban dwellers scored higher (mean 11.9, SD 4.5) than rural (mean 10.4, SD 4.3). Similarly, males scored higher (mean 11.9, SD 4.4) than females (mean 11.1, SD 4.7). Among the age groups, participants 25–34 years scored the highest (mean 12.2, SD 4.4) followed by 35–44 age groups (mean 11.8, SD 4.3), and those aged over 55 years scored the lowest (mean 9.7, SD 4.7). Participants with higher education scored higher (mean 14.2, SD 4.2) than

TABLE 1 | Knowledge score of COVID-19 by demographic characteristics ($n = 618$).

Variables	Frequency (%)	Mean	SD	t/F–ratio	P-value
Province					
Karnali_6	110 (17.8)	10.4	4.4	3.72	0.001
Gandaki_4	107 (17.3)	12.4	4.6		
Bagmati_3	96 (15.5)	10.7	3.8		
Province_1	92 (14.9)	11.8	4.3		
Sudurpaschim_7	80 (12.9)	11.2	3.8		
Province_2	75 (12.1)	12.4	5.0		
Province_5	58 (9.4)	12.8	5.6		
Ecological region					
Hill districts	393 (63.6)	11.4	4.5	−1.53	0.127
Terai districts	225 (36.4)	11.9	4.5		
Place of residence					
Urban municipality	488 (79.0)	11.9	4.5	3.39	0.001
Rural municipality	130 (21.0)	10.4	4.3		
Age					
18–24	151 (24.4)	11.7	4.5	5.28	0.000
25–34	221 (35.8)	12.2	4.4		
35–44	123 (19.9)	11.8	4.3		
45–54	48 (7.8)	10.6	4.5		
55 and above	75 (12.1)	9.7	4.7		
Gender					
Male	390 (63.1)	11.9	4.4	2.08	0.038
Female	228 (36.9)	11.1	4.7		
Caste and ethnicity					
Brahmin/chhetri	264 (42.7)	11.9	4.2	1.89	0.129
Jana jaati	160 (25.9)	11.7	4.6		
Dalit	110 (17.8)	10.9	5.1		
Madhesi/muslims and others	84 (13.6)	11.0	4.4		
Education					
No formal education	98 (15.9)	8.9	3.9	27.94	0.000
Primary (1–5)	84 (13.6)	10.3	4.5		
Secondary (6–12)	340 (55.0)	11.9	4.3		
Higher education	96 (15.5)	14.2	4.2		
Occupation					
Labor and others	240 (38.8)	11.3	4.4	9.08	0.000
Service	106 (17.2)	13.5	4.3		
Foreign employment	104 (16.8)	10.7	4.6		
Farming	94 (15.2)	10.4	4.8		
Business and self-employment	74 (12.0)	12.5	3.8		
Marital status					
Married	475 (76.9)	11.4	4.5	8.82	0.000
Ever married	127 (20.6)	12.5	4.4		
Single (widow, divorced)	16 (2.6)	7.8	4.4		

those with no school education (mean 8.9, SD 3.9). Participants who reported their main occupation as service had highest knowledge scores (mean 13.5, SD 4.3), followed by the business

or self-employed group (mean 12.5, SD 3.8), while the farmers scored the lowest (mean 10.4, SD 4.8). Ever married participants scored highest (mean 12.5, SD 4.4), while single (widowed or divorced) scored the lowest (mean 7.8, SD 4.4) (**Table 1**).

Attitude Toward COVID-19

The overall attitude mean score among the study participants was 2.7 (SD 1.8, range 0–6). Attitude scores differed across groups (**Table 2**). Residents in Karnali had the highest attitude score (mean 3.7, SD 2.0), while Province 1 and 2 scored the lowest (mean 2.0, and SD 1.5 and 1.8, respectively). Participants aged between 25 and 34 had the highest attitude score (mean 3.0, SD 1.8), while those 45–54 and 55 + scored the lowest (mean 2.3, SD 1.6). Similarly, participants having higher education had higher score (mean 3.4, SD 1.5) than those with no school education. Respondents employed in the service sectors had higher attitude score (mean 3.6, SD 1.7) while the labor group had the lowest (mean 2.4, SD 1.7) (**Table 2**).

Practice Toward COVID-19

The participant's overall mean practice score was 9.9 (SD 1.93, range 3–12). However, the score differed between groups (**Table 3**). Residents in Gandaki had the highest score (mean 10.8, SD 1.6) and Karnali reported the lowest (mean 9.4, SD 1.7). Urban respondents scored slightly more (mean 10.0, SD 1.9) than rural (mean 9.5, SD 1.9), and female (mean 10.2, SD 1.9) more than male (mean 9.7, SD 2.0). Among caste and ethnic groups, Bramhin/Chhetri had the highest practice score (mean 10.1, SD 1.9) and the lowest were found among Dalit respondents (mean 9.5, SD 1.9). Those with higher education level had the highest score (mean 10.7, SD 1.6), and the lowest with no school education or primary level education (mean 9.2, SD 2.0). Respondents working in service occupations had the highest practice score (mean 10.5, SD 1.7) and again, farmers scored the lowest (mean 9.2, SD 1.9) (**Table 3**).

Correlation Between Knowledge, Attitude, Practice and Demographic Characteristics

This study interpreted the correlations criteria with r value 0–0.25 = a weak correlation, 0.25–0.5 = fair correlation, 0.5–0.75 = moderate correlation, and > 0.75 = strong correlation (14). **Table 4** shows the correlation between KAP scores and their relation with demographic characteristics. The analysis of knowledge-practice ($r = 0.19$, $p < 0.01$) and attitude-practice ($r = 0.08$, $p < 0.05$) both showed significant positive linear correlations, however they were weak (**Table 4**).

The relationship between knowledge and education was fairly strong ($r = 0.34$, $p < 0.01$) but with other variables was weak. Knowledge was positively correlated with participant's province ($r = 0.11$, $p < 0.01$) while the relationship with place of residence ($r = -0.13$, $p < 0.01$), Age ($r = -0.11$, $p < 0.01$) Caste and ethnicity ($r = -0.11$, $p < 0.01$) and gender ($r = -0.08$, $p < 0.05$) were negatively correlated. Attitude was correlated with province ($r = -0.23$, $p < 0.01$), ecological area ($r = -0.25$, $p < 0.01$), place of residence ($r = -0.08$, $p < 0.05$), age ($r = -0.12$, $p < 0.01$) and the education level of participants ($r = 0.16$, $p < 0.01$). All of them showed negative correlation except education,

TABLE 2 | Attitude toward COVID-19 score by demographic characteristics ($n = 618$).

Variables	Frequency (%)	Mean	SD	t/F–Ratio	P-value
Province					
Karnali_6	110 (17.8)	3.7	2.0	11.76	0.000
Gandaki_4	107 (17.3)	3.0	1.5		
Bagmati_3	96 (15.5)	3.0	1.6		
Province_1	92 (14.9)	2.0	1.5		
Sudurpaschim_7	80 (12.9)	2.4	1.9		
Province_2	75 (12.1)	2.0	1.8		
Province_5	58 (9.4)	2.8	1.7		
Ecological region					
Hill districts	393 (63.6)	3.1	1.8	6.53	0.000
Terai districts	225 (36.4)	2.1	1.7		
Place of residence					
Urban municipality	488 (79.0)	2.7	1.8	−1.97	0.049
Rural municipality	130 (21.0)	3.0	1.9		
Age					
18–24	151 (24.4)	2.8	2.0	3.68	0.006
25–34	221 (35.8)	3.0	1.8		
35–44	123 (19.9)	2.6	1.7		
45–54	48 (7.8)	2.3	1.6		
55 and above	75 (12.1)	2.3	1.6		
Gender					
Male	390 (63.1)	2.8	1.9	0.33	0.740
Female	228 (36.9)	2.7	1.7		
Caste and ethnicity					
Brahmin/chhetri	264 (42.7)	2.8	1.7	1.75	0.155
Jana jaati	160 (25.9)	2.7	1.8		
Dalit	110 (17.8)	2.9	2.0		
Madhesi/muslims and others	84 (13.6)	2.4	1.9		
Education					
No formal education	98 (15.9)	2.4	1.8	6.74	0.000
Primary (1–5)	84 (13.6)	2.4	1.9		
Secondary (6–12)	340 (55.0)	2.7	1.8		
Higher education	96 (15.5)	3.4	1.5		
Occupation					
Labor and others	240 (38.8)	2.4	1.7	8.02	0.000
Service	106 (17.2)	3.6	1.7		
Foreign employment	104 (16.8)	2.7	1.9		
Farming	94 (15.2)	2.5	1.8		
Business and self-employment	74 (12.0)	2.9	1.7		
Marital status					
Married	475 (76.9)	2.7	1.8	3.73	0.025
Ever married	127 (20.6)	3.1	1.8		
Single (widow, divorced)	16 (2.6)	2.1	1.9		

however those relationships were weak. Likewise, practice score correlations were weak in relation to place of residence ($r = -0.10$, $p < 0.05$), gender ($r = 0.12$, $p < 0.01$) and education ($r = 0.25$, $p < 0.01$). Gender and education were positively correlated with practice, while with place of residence was negative (**Table 4**).

TABLE 3 | Practice toward COVID-19 score by demographic characteristics (n = 618).

Variables	Frequency (%)	Mean	SD	t/F–Ratio	P-value
Province					
Karnali_6	110 (17.8)	9.4	1.7	7.93	0.000
Gandaki_4	107 (17.3)	10.8	1.6		
Bagmati_3	96 (15.5)	10.1	1.9		
Province_1	92 (14.9)	9.5	2.2		
Sudurpaschim_7	80 (12.9)	9.3	1.9		
Province_2	75 (12.1)	9.9	1.9		
Province_5	58 (9.4)	9.9	2.0		
Ecological region					
Hill districts	393 (63.6)	9.8	2.0	−0.92	0.357
Terai districts	225 (36.4)	10.0	1.9		
Place of residence					
Urban municipality	488 (79.0)	10.0	1.9	2.51	0.012
Rural municipality	130 (21.0)	9.5	1.9		
Age					
18–24	151 (24.4)	10.0	1.9	0.45	0.773
25–34	221 (35.8)	9.8	1.9		
35–44	123 (19.9)	9.8	1.9		
45–54	48 (7.8)	9.6	2.0		
55 and above	75 (12.1)	9.9	1.9		
Gender					
Male	390 (63.1)	9.7	2.0	−2.99	0.003
Female	228 (36.9)	10.2	1.9		
Caste and ethnicity					
Brahmin/chhetri	264 (42.7)	10.1	1.9	2.61	0.050
Jana jaati	160 (25.9)	9.7	2.0		
Dalit	110 (17.8)	9.5	1.9		
Madhesi/muslims and others	84 (13.6)	10.0	2.1		
Education					
No formal education	98 (15.9)	9.2	2.0	14.48	0.000
Primary (1–5)	84 (13.6)	9.2	1.9		
Secondary (6–12)	340 (55.0)	10.0	1.9		
Higher education	96 (15.5)	10.7	1.6		
Occupation					
Labor and others	240 (38.8)	10.0	2.0	11.14	0.000
Service	106 (17.2)	10.5	1.7		
Foreign employment	104 (16.8)	9.2	1.9		
Farming	94 (15.2)	9.2	1.9		
Business and self-employment	74 (12.0)	10.4	1.7		
Marital status					
Married	475 (76.9)	9.8	2.0	2.55	0.079
Ever married	127 (20.6)	10.2	1.8		
Single (widow, divorced)	16 (2.6)	9.8	1.8		

Linear regression analysis showed that knowledge ($\beta = -0.13$, $p < 0.01$), province ($\beta = -0.12$, $p < 0.05$), ecological area ($\beta = 0.14$, $p < 0.01$), age ($\beta = 0.09$, $p < 0.05$), gender ($\beta = 0.18$, $p < 0.01$), and education ($\beta = 0.27$, $p < 0.01$) significantly associated with practice score after controlling the confounders (**Table 5**).

TABLE 4 | Correlation matrix among interest variables (n = 618).

	Pearson/spearman's rho correlation coefficient		
	Knowledge	**Attitude**	**Practice**
Knowledge	–		
Attitude	0.04	–	
Practice	0.19**	0.08*	–
Province	0.11**	−0.23**	−0.04
Ecological area	0.06	−0.25**	0.04
Place of residence	−0.13**	0.08*	−0.10*
Age in years	−0.11**	−0.12**	−0.03
Caste and ethnicity	−0.11**	−0.04	−0.07
Gender	−0.08*	−0.02	0.12**
Education	0.34**	0.16**	0.25**
Primary occupation	0.00	0.06	−0.06
Marital status	0.04	0.07	0.07

**Correlation is significant at the 0.01 level (2-tailed).
*Correlation is significant at the 0.05 level (2-tailed).

TABLE 5 | Result of linear regression analysis on factors associated with practices toward COVID-19.

Independent variables	Coefficient (β)
Knowledge	0.13**
Attitude	0.06
Province	−0.12*
Ecological area	0.14**
Place of residence	−0.01
Age	0.09*
Gender	0.18***
Caste and ethnicity	0.00
Education	0.27***
Primary occupation	0.01
Marital status	0.07

*P < 0.05, **P < 0.01, ***P < 0.001.

DISCUSSION

Within a short period of time COVID-19 has had a huge impact on people's lives. However, there has been limited research to understand public knowledge, attitudes and practices toward COVID-19 in Nepal. This study identifies correlations between KAP and population characteristics, which may inform and support planners and decision makers in policy formulation and in implementing pandemic response plans.

The study found the average score for knowledge and attitude at 43 and 45%, respectively, while the average practice score was high at 82.5%. These low scores in knowledge and attitude indicate a huge gap in knowledge and attitudes relating to COVID-19. The scores differed across the background and characteristics of the sample. Participants in Karnali, living in rural areas, having no school education, who were older, female, and widowed or divorced, had the lowest knowledge scores.

This contrasts with studies conducted in China and Malaysia that found older age groups and females had greater knowledge (15, 16). Higher levels of knowledge about COVID-19 have also been found in studies in other Asian countries among the general public (15–17). The paradox of these findings from Nepal, and importance for public health strategies, is that the groups with lowest levels of knowledge, attitudes and practice also seem to be those most vulnerable to the consequences of COVID-19 infection. Older age groups are more likely to die as a result of COVID-19 and poorer groups (likely to be rural and with no education) are least likely to be able to cope with additional health care costs or loss of income due to being sick. Our findings suggest that while implementing education, awareness raising and risk communication intervention greater emphasis needs to be placed in Karnali and other rural areas targeting to isolated and vulnerable populations such as older age group, people with no education, women and widowed or singles.

Our study also showed a significant level of perceived risk among the survey population indicating that the public did not have very high expectation of easy availability of health services for them and also do not believe that government will easily control the pandemic. Participants living in rural hills, unmarried, younger age group, having higher education and working in the service sectors expressed pessimism, whilst people living in urban areas, working as labor and with little education showed more positive attitudes. Negative attitudes and high perceived risks of COVID-19 may be explained by perceptions of a slow and ineffective response by the government to the pandemic (18) and also doubts about the availability and equity of access to healthcare services (19). This is consistent with a recent study conducted in Nepal, which suggests that people tend to express negative emotions when experiencing increased anxiety and stress (9).

Despite the low knowledge and pessimistic attitudes, adherence of precautionary measures by the study population was high. People living in more developed and accessible areas, privileged caste groups, those having higher education and women reported practicing better precautionary measures. Consistent to our finding, previous studies in other settings also showed that men compared to women, individuals with lower education and poor knowledge about COVID-19 than with higher level education and knowledge tended to practice more risk behaviors (15). Furthermore, the less precautionary measures observed among the people living in the remote areas like Karnali province could be explained by more barriers faced to adherence, such as limited water supplies, and also that adopting precautionary measures such as wearing masks and use of hand sanitizer may not be affordable. Pertinent to this is the Nepal Demographic Health Survey finding that only 26% of households have handwashing facilities with soap and water in Karnali province (20).

Consistent to previous studies, our findings confirmed positive correlations between knowledge-practice and attitude-practice (17), however there was no correlation between knowledge-attitude. This study was implemented during the initial phase of the COVID-19 outbreak and expressed attitudes and beliefs by the study population may change as the pandemic evolves over the coming months. Higher practice scores compared to knowledge and attitude could be due to the lockdown imposed by the government that limited individual mobility and exposure to crowds. The study found that only education had significant positive correlation with knowledge, attitude and practices. It found a weak but statistically significant negative correlation between knowledge and the other demographic factors Interestingly province, ecological zone and age showed significant associations with practice after controlling confounders. These findings are in line with the results of some previous studies (21, 22). Further study is recommended to reaffirm and track changing correlations between knowledge, attitude and practice, as this study was a cross-sectional survey conducted during the initial phase of pandemic outbreak.

Strength and Limitation of the Study

The study sample of 618 was recruited from 26 health facilities across the country and included population groups from different strata including ecological region, caste ethnicity, and both urban and rural residents; although the proportion of urban participants (79%) was disproportionately higher than the national rate and this sampling bias may affect the generalizability of the findings.

The purposive selection of health facilities conducting fever clinics may have resulted the selection bias. Likewise, further bias may have occurred with the exclusion of people under 18 years and individuals with communication difficulties. Furthermore, the absence of visual cues on the phone might have hindered attempts to create an enabling environment for the interviews (23). We also acknowledge the possibility of social desirability bias as the data were self-reported.

CONCLUSION

The findings of this study showed that the general public in Nepal have been following some precautionary practices despite their low level of knowledge and pessimistic attitude toward COVID-19 pandemic. In this study it is interpreted that the higher the attitude score the higher the perceived risk. The study demonstrated limited positive correlations between knowledge-practice and attitude-practice, but also disparities, suggesting that higher levels of knowledge and positive attitudes can result in good practices to prevent spread and remain safe during the current pandemic. There is a need to improve knowledge about COVID-19 across all parts of the population, but particularly to design and implement more targeted strategies for community-based awareness raising and risk-reduction communication intervention to enable improvements in attitudes and practices toward COVID-19 amongst the most vulnerable groups.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Nepal Health Research Council (NHRC) - ERB Protocol Registration No. 317/2020P. The patients/participants provided their verbal informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

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Epidemic Prevention During Work Resumption: A Case Study of One Chinese Company's Experience

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Background: The COVID-19 epidemic not only brings challenges to the health of people all over the world, but also impacts the global economy, and employment. Therefore, promoting industry and business to resume work safely has become an important step to be taken by all countries in overcoming the economic recession and restarting growth.

Objective: This study aims to elaborate on epidemic prevention measures a Chinese company (Company C) took during work resumption.

Methods: In this study, we used a case study design, with field research method applied to data collection and analysis.

Results: It has been identified that Company C took a range of measures to prevent the outbreak of COVID-19 inside the company, which involve work resumption preparation (information survey, health training, work resumption plan, epidemic prevention plan), facilities management, materials management, employee activity management, and so on.

Conclusion: When the COVID-19 epidemic was initially controlled in February, the Chinese government allowed enterprises to resume work voluntarily, which did not bring about a rebound in the epidemic. One important reason is that Chinese enterprises have taken multiple measures to prevent the spread of the COVID-19 virus. Company C's practices could shed some light on how companies in Western countries resume their work during the COVID-19 pandemic.

Keywords: COVID-19, work resumption, China, company, epidemic prevention

INTRODUCTION

The COVID-19 epidemic which began in December 2019 not only poses challenges to the health of people all over the world, but has also had a negative impact on the global economy (1–4). As a developing country, the coronavirus epidemic also dealt a greater blow to China's economy. According to the national bureau of statistics, China's GDP fell 9.8% in the first quarter from a year earlier after factories, shops and travel were closed to contain the infection. This is the first time since 1979 that China has witnessed such a sudden and massive contraction in its economy (5). More than 460,000 Chinese firms closed permanently in the first quarter and more than half of them have operated for under 3 years (6).

Clearly, it is an important task for all countries to restart economic activities and promote enterprises to resume production and work. Many countries and regions began to restart economic activities and promote enterprises to resume work when the virus spread was shown to be vigorously controlled and prevented. However, the global epidemic is still severe, and enterprises still face many difficulties, the largest of which is to avoid the rebound of the epidemic caused by cluster infections occurring in the process of work resumption. In March, a significant COVID-19 cluster occurred in Smithfield Plant in South Dakota, USA, where 644 employees were infected with the COVID-19 (7). This is not an isolated case. Covid-19 clusters have also appeared in meatpacking plants around other countries including Canada, Spain, Ireland, Brazil, and Australia (8). Meatpacking plants are not the only businesses where cluster infections occurred. Also, cluster infections were reported in a parcel delivery company in Germany (9), a Brazilian petroleum company (10), and abattoirs in France (11). This conforms to the warning of Dr. Anthony Fauci, the top infectious disease expert in the United States. He claimed that pushing too quickly to reopen businesses during the COVID-19 pandemic could trigger an outbreak that you may not be able to control (12). Therefore, how to implement countermeasures to prevent cluster infections in the process of work resumption is of great significance.

When the epidemic was initially brought under control on February 10, 2020, the Chinese government began to restart the economy and allowed enterprises to resume work and production voluntarily. The resumption of production and work for Chinese enterprises did not bring about a rebound in the epidemic. Data shows that from February 10 to June 2, the number of confirmed cases and deaths caused by COVID-19 in China continued the downward trend (13). This is not only due to the prevention efforts the government at the level of both cities and villages have took, but also due to the efforts conducted by Chinese companies in the process of work resumption. The practices in the past 4 months shows that the Chinese companies' measures on preventing the epidemic during work resumption have been proven successful. These successful practices of epidemic prevention Chinese companies took could shed some light on how companies in other countries to resume their work and production.

It is an impossible task to sum up the experiences of epidemic prevention of all companies in China. Therefore, we use a case study as the main method, and obtain the research data from a typical company by field research and semi-structured interviews, which could deeply and systematically reproduce the practices of the company's measures on epidemic prevention. These measures will be approached from multiple aspects such as work resumption preparation, facilities management, materials management, and employee activity management, which could comprehensively reproduce the company's experiences concerning epidemic prevention during work resumption.

METHODS

Case research aims to understand the complexity of a demarcated entity by performing an in-depth and intensive analysis of the

selected case (14, 15). Given its potential for understanding complex processes as they occur in their natural setting, case study is increasingly used in a wide range of health-related disciplines and fields, including medicine, nursing and health management (16).

Research Question

As argued by Yin, case studies are particularly suitable for answering "how" research questions (17), our research question is in exactly how a specific company (Company C) during the COVID-19 epidemic successfully practice epidemic prevention while resuming its work and production.

Case Selection

In this study, Company C is selected as our research case. The primary reason we choose Company C as research case is that it made great achievements on epidemic prevention during work resumption. Company C is a Sino-US joint venture and a listed company in China, located in Qingdao, China. Company C has 500 employees, and its business is spread all over the country including Hubei, Hunan, Henan, Zhejiang, and other provinces where the coronavirus epidemic is serious, this results in big challenges for epidemic prevention during the process of work resumption. The company is located in Qingdao, which is a famous tourism city where the employees travel a lot. This also brings pressure to the company's epidemic prevention. Through reasonable planning and practice, Company C has generally prevented the coronavirus epidemic in the process of work resumption, and no confirmed or suspected case occurred among the company's employees or managers. The second reason we choose company C is that it is a "typical" case. Company C not only possesses the job characteristics (task interdependence, Job autonomy, Feedback, etc.) of modern workplace (18), but also has the physical environment characteristics (factory, office building, laboratories, etc.) of manufacturing companies (19). Thus, it can be seen a typical case of modern manufacturing company. The third reason we choose company C is that one of the authors of this study is an employee of Company C, which provides convenience for us to enter the company and carry out field work and interviews during the epidemic.

Data Collection

In case studies, researchers are encouraged to use a variety of methods to collect data in order to describe or explain a single case comprehensively and deeply (20). In this study, we use the methods of semi-structured interviews method and field research to collect data. In semi-structured interviews, semi-structured interview guidelines were used to collect qualitative data focused on the research problem (21, 22). Field research was originally an anthropological research method, and then it was expanded to other disciplines such as sociology, political science and management (23). Now, it has become a common method for collecting data during case studies (24). This method requires researchers to go into the scene and use techniques such as observation, interruption analysis and verbalizations to collect data. In observation, behavior is observed and recorded on document sheets (25). In interruption analysis, the person interrupted by the observer who ask questions about what has

been previously observed. In verbalizations, participants involved in the study are asked to comment on their activities in or after the activity. Accordingly, observation, interruption analysis, and verbalizations were used to examine how the managers and employees have done to prevent the outbreak of COVID-19 inside the company.

Twelve participants are involved in the semi-structured interviews and field research and informed consent was obtained from all participants. Participants consist of 6 managers (administration department, human resources department, production department, procurement department, training and conference department, canteen department) and 6 employees (security department, cleaning department, marketing department, finance department). In observation, the participant's behavior concerning pandemic prevention was recorded on document sheets. In interruption analysis, the observer interrupted the participants to ask questions about what has been previously observed. In verbalizations, participants are asked to comment on their activities regarding epidemic prevention in or after their activities.

Data Analysis

Data were organized and analyzed using the method of inductive content analysis. We follow scientific analysis process for the content analysis of the data based on the methodological approach by Elo and Kyngäs (26). In the preparation phase, the unit of analysis was selected. In the organizing phase, sub-categories about company epidemic prevention were identified as much as possible (27–29). Then, similar sub-categories were grouped into main categories (30). In the reporting phase, our analyzing process were reported.

To increase the trustworthiness of this study, two researchers independently coded all raw data, and coding disagreements were discussed until consensus was reached (31). In addition, during the coding process, codes were expanded and changed to ensure codes were extremely exhaustive (32). Furthermore, when the researchers reviewed the data, feedback loops were frequently used to ensure that the emerging codes, sub-themes, or themes were amended if necessary (33).

RESULTS

Based on our field research, it has been found that Company C's epidemic prevention measures are composed of the following themes. What need to be explained is that, there are a variety of departments in Company C, and some measures were taken at the company level, including employee information registration, health education, entrance management, public place management, dining activity management, etc., while some measures were taken at the department level. For example, productive activity management was at the workplace/factory level, cooking activity management was at the canteen level and so on.

In Preparation for the Resumption of Work and Production

Under the pressure of economy and unemployment, the Chinese government allowed enterprises to resume work

and production voluntarily on February 10, 2020. After comprehensive consideration, Company C decided to resume production and work on February 24, 2020 and made the following preparations for reopening its work and production.

Employee Information Report

Company C has branches all over China, including the most affected provinces such as Hubei, Hunan, Henan, Zhejiang, and so on. The sale employees of Company C made business trips to Wuhan, Huanggang, Xiaogan and other epidemic-stricken cities in Hubei province during the outbreak of the epidemic, and all returned to Qingdao before the Spring Festival[1]. In addition, many employees' hometowns are outside Qingdao city or even Shandong Province, most of whom went back to their hometowns during the Spring Festival. This would increase the likelihood of their exposure to the Virus. The situations above increased the uncertainty of Company C's epidemic prevention. All employees in Company were asked to report their personal information on Tencent or WeChat platform before work resumption. All employees need to promise that all the information reported is true. Company C also keeps the information on file for future communication with the city's health administration department and emergency management department. The registered information is shown below:

(1) *Personal health status: body temperature, fever, head pain, fatigue, cough, chest tightness.*
(2) *Business travel information before the Spring Festival: travel time, travel route (flight/train shift), important locations arrived related to the epidemic, close contacts related to the epidemic.*
(3) *Travel information during the Spring Festival: travel time, travel route, important locations arrived related to the epidemic, close contacts related to the epidemic.*
(4) *Family members' travel information during the Spring Festival: travel time, travel route, important locations arrived related to the epidemic, close contacts related to the epidemic.*
(5) *Personal situation when staying in Qingdao: important locations arrived related to the epidemic, close contacts related to the epidemic.*
(6) *Other information related to the Covid-19 pandemic.*

Source: Company C's internal website
(authorized by Company C's administrative department)

Flexible Work Resumption

If all employees return to work, it is difficult to maintain a safe distance between each other. Thus, Company C formulated a plan for work resumption which they called gradual and flexible work resumption. As for gradual resumption plan, core employees in all departments are asked to resume work in the company. In contrast, other employees are required to work at home. They would be allowed to return to the workplace when the epidemic is relieved. In terms of the flexible work resumption

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[1]These employees went on a business trip from December 2019 to January 2020, when the epidemic had already broken out in Hubei province with Wuhan as the epicenter. However, China and the public did not have a full understanding of the epidemic during this time, so the company still arranged sales staff to travel to the above locations during this period.

plan, the core employees asked to resume work don't have to work in the company every day. They need to work in the company only when there is work that has to be done in the company. This was a countermeasure to further reduce the staff density in the company. For employees who work at home, the company formulated an epidemic prevention plan to trace their health conditions every day, which could ensure their health and safety. An interview with the human resources manager of Company C is as follows:

> *Our company's gradual and flexible resumption plan not only maintained normal operation of our company, but also ensured the health of the company's employees during the epidemic. For example, in the financial department, we arranged the accounting supervisor as the first batch of personnel to resume work in order to restart the department's business quickly and formulate the work resumption plan in financial department as soon as possible. Other employees in the financial department work at home. This plan works well. I think it is good for the company and its employees.*

> *Source: Ms. Qiao, Manager of human resources department in Company C*

Company C's Action Plan on the Epidemic Prevention

In response to the spread of the epidemic, Company C set up COVID-19 epidemic prevention committee and took a range of measures to protect its employees from being infected. Epidemic prevention measures employed by Company C consist of the following parts. First, COVID-19 epidemic prevention committee in company C examined the government's guidance documents carefully, including "Notices on epidemic prevention during work resumption" (issued by Qingdao Municipal Government, February 6), "Opinions on Epidemic Prevention during Work Resumption" (issued by People's Government of Shandong Province, February 19) and the "Guidelines on Epidemic Prevention for Work Resumption of Enterprises and Institutions" (issued by People's Government of Shandong Province, February 21). Second, COVID-19 epidemic prevention committee in Company C tried to put forward prevention measures available for the company's actual situation based on the government's guidance documents. Third, COVID-19 epidemic prevention committee held 3 meetings to examine the feasibility of these countermeasures in depth, and made some refinements and proposed a detailed plan for epidemic prevention, mainly reflected in the following two documents, that is, "Management plan during Covid-19" and "Notices on dining service management during Covid-19 pandemic." In order to improve the prevention measures and promote the epidemic prevention action, Company C clarified the responsibilities of each department during the epidemic prevention (**Figure 1**).

Health Education

Adequate knowledge of personal health and epidemic prevention is the basis for employees to prevent the epidemic at work. Company C conducted online health education related to the epidemic before work resumption. The scope of health education for the employees includes hand washing, drinking water, mask wearing, indoor ventilation, disinfection measures, health habits, and self-psychological adjustment. The main contents of the health education on are as follows:

FIGURE 1 | Divisions of various departments in epidemic prevention.
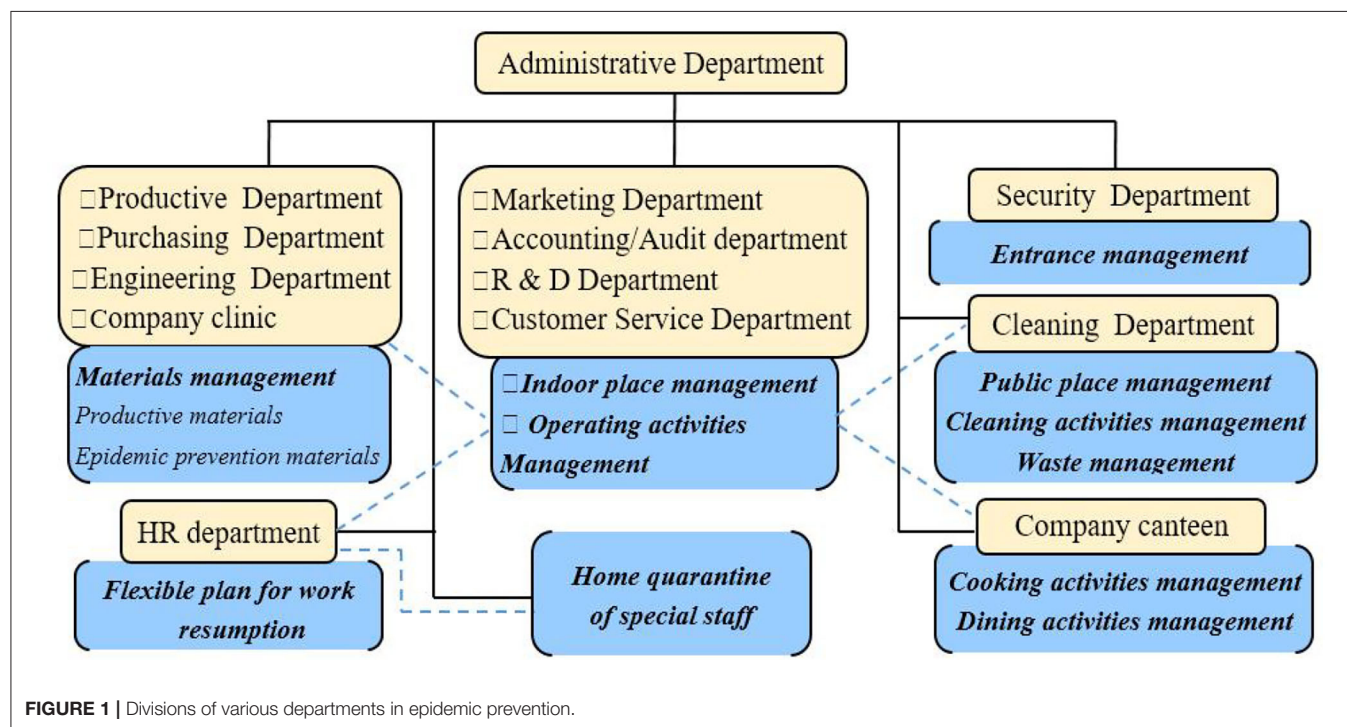
(1) *wear masks when you're out, try to take private cars, bicycles and other means of transportation instead of public transportation.*
(2) *If you have to take public transportation, remember to wear a mask all the way and try to avoid touching the vehicle with your hands.*
(3) *If you touch public goods during your trip, use alcohol to disinfection your hand if conditions permit, wash your hands in time when you arrive at home or the company, and fully disinfect your exposed belongings.*
(4) *do not rub your eyes, nose, and mouth with water during going out.*
(5) *You and your family members should try their best to avoid going to public places with large crowds. If you have to, remember to take the protective measures above.*

Source: Company C's internal website
(authorized by Company C's administrative department)

Facilities and Material Management During Work Resumption

Through analysis on the data from semi-structured interview and field research, it has been found that Company C's place and material management includes the following four aspects during the epidemic.

Entry/Exit Management

(1) **Entry/exit management** "One entry, one exit" method was took to keep the company safe.
(2) **Entry/exit authorization** Company C formulated different Entry/exit authorizations for different personnel, which could inhibit cross-infection of the COVID-19 epidemic in the company. An interview with the company's entry/exit manager can clearly show how Company C has implemented entry/exit authorization.

> *Our company formulated various entry/exit authorization for different types of personnel. If the visitors are the employees of our company, they will receive temperature monitoring to check whether their body temperature is lower than 37 degrees. If the employee's body temperature exceeds 37 degrees, he/she is forbidden to enter the company. Accordingly, we will report this employee's temperature information to the company's administrative department, and the employee will be required to stay at home for self-isolation for 14 days. . . .*
>
> *Source: interview with Mr. Zhu, the security manager*

(3) **Free mask distribution** At the beginning of work resumption, Company C distributed free masks to its employees and visitors when masks were in short supply. With the increase of mask production in China, masks can be purchased from pharmacies at normal prices in April. After April 6, Company C no longer provide free masks for its employees and visitors, and require them to wear a mask to go inside and outside.

(4) **Hand Disinfection** Company C's security guards were responsible for hand disinfection, which was offered to individuals entering the company.

Indoor Place Management

(1) **Indoor place disinfection** Company C conduct daily disinfection in their offices, factories, canteens and other indoor places. For the offices, the ground is disinfected with 84 Disinfectant twice a day. Desktops and office equipment (such as telephones, computer screens, keyboards, mouse, calculators, printers, door handles, and window handles) should be disinfected twice a day. Notice that the power supply should be cut off when electronic equipment is disinfected. As for the factory, the central control room, the operation room, external operation room, duty room and other important areas are disinfected twice a day, and production tools such as machines and equipment are disinfected once a day. In terms of the canteen, the ground is disinfected with 84 Disinfectant three times a day, the tables and chairs are disinfected with alcohol-based disinfectant three times a day, and utensils are disinfected with ultraviolet and high temperature three times a day. Employees are responsible for the ventilation of the room where they work.
(2) **Indoor place ventilation** Company C conducted ventilation for indoor places such as offices, factories, canteens three times a day for 20–30 min each time. Employees in different departments are responsible for the ventilation of their own spaces. Ventilation is carried out after disinfection.
(3) **Stopping the use of the central air conditioner** Given central air conditioner may cause cross infection, Company C turned off the company's central air conditioner during the epidemic. And thus, independent air conditioners are used to regulate the indoor temperature.

Public Place Management

(1) **Frequent disinfection in public places** Public places are disinfected frequently. An interview with the company's cleaning staff can show how public spaces were disinfected.

> *During the epidemic, our company increased the frequency of cleaning and disinfection in public places. Public places such as the corridors, stairs, halls, toilets and garages, should be disinfected twice a day with 84 Disinfectant. Public office spaces, such as conference rooms, reception rooms, recruitment rooms, lounge, also need to be disinfected twice a day. Escalators, door handles and other key positions are disinfected three or four times a day.*
>
> *Source: interview with Ms. Liu, the company's cleaning staff*

(2) **Putting hand sanitizer in the bathroom** The cleaning department put hand sanitizer in the bathroom to help employees get rid of hand bacteria.
(3) **Stopping the use of the elevator** The elevator is a closed space with high personnel density, which may increase the risk of cross-infection. Thus, Company C temporarily stopped the use of the elevator during the epidemic.

Management on Epidemic Prevent Materials, Productive Materials, and Waste Materials

(1) Epidemic prevention materials. In response to the epidemic, the company's medical department have access to sufficient medical supplies for all employees, which include N95 masks, disinfectants, infrared thermometers, protective suits, antibiotic hand sanitizer, disposable gloves, and so on.

(2) Raw material procurement During the epidemic, the procurement department optimized its procurement process and methods in order to reduce the risk of exposure to the virus. The following interview with the manager in the procurement department could illustrate the procurement process and methods during the pandemic.

> *During the epidemic, in order to reduce the risk of Virus infection during external procurement, we prefer to purchase the raw materials through online platforms, and the supplier will deliver the goods to us. We will go out to purchase raw materials when absolutely necessary. We will wear masks and gloves all the time when we go out to purchase raw materials. When we complete our outdoor procurement, we should register relevant information about our outdoor procurement, and receive temperature monitoring before entering the company. Raw material procurement both online and offline will be disinfected.*
>
> *Source: Mr. Chen, manager of the company's procurement department*

(3) Waste materials The cleaning department disinfects and destroys garbage such as discarded masks and gloves, disposable plastic food containers, and manufacturing wastes as soon as possible, which could inhibit the spread of the virus within the company.

Employee Activity Management During Work Resumption

Through the analysis of the data obtained from semi-structured interviews and field research, it has been found that Company C's employee activity management includes the following four aspects during the epidemic.

Operating Activities

(1) Administrative activities Administrative employees are required to wear masks all the time after entering the company except for dining time, and should keep 1 meter distance from each other. Masks worn by employees should be disposable medical masks or N95 masks. Considering that group office activities are more likely to lead to cross-infection among employees. Company C suspended group office activities during the epidemic. The following interview with the manager of training and conference department could display administrative employee activities.

> *During the epidemic, in order to avoid cross-infection caused by close contact among our administrative employees, we completely stopped offline meetings, and switched to WeChat and Tencent for online meetings. In addition, we suspended gathering activities such as team building and collective workshops. In fact, what concerned us most is how to deal with visitors from other companies due to business needs. To deal with this issue, we not only require them to comply with our entry/exit management scheme, but also try our best to control the number of visitors and reduce the length of their visits.*
>
> *Source: interview with Ms. Wen, manager of training and conference department*

(2) Productive activities Considering that the worker density in the factory is relatively high, workers in the factory are required not only to wear N100 masks but also disposable gloves and protective caps when they are working. In addition, private talks are not permitted during the production, and smoking is strictly prohibited in the any places in the factory during the epidemic. In order to lower the respiratory load of workers, the factory provided a flexible working time and an airy working environment for its workers. Besides, when workers took a break, they were allowed to go out of their workshops and take off their masks for taking a good breath under the condition that they should keep a physical distance between each other.

(4) Business activities. At the beginning of work resumption, Company C suspended all its business trips and maintained its business negotiation through Internet. After mid-April, employees were allowed to make business travel, and were provided with sufficient masks and portable disinfectant. Notice that they were asked to report their personal health information every day.

Cleaning Activities

(1) Cleaning process The cleaning department is responsible for cleaning and disinfecting all the public areas in the company. The company has made strict regulations on the cleaning process. The following interview with the cleaning staff could show the cleaning process in detail.

> *Before our everyday work, we need to receive body temperature measurement and hand disinfection from the company. Masks and gloves are required to wear during work. Of course, cleaning is a dangerous job during the epidemic, so we are required to take self-protection precautions during work. We should wear gloves and masks in the correct way. We wash and disinfect our hands and faces immediately after work. The company provides us with exclusive cleaning tools to prevent cross-infection.*
>
> *Source: Interview with Ms. Liu, cleaning staff*

(2) Supervision scheme To ensure the quality of the cleaning work, the manager of the cleaning department would conduct post-inspection and temporary spot checks on the cleaning work.

Cooking Activities

(1) Food Ingredients procurement. During the epidemic, the company's canteen standardized the purchasing process of food ingredients, and the details are as follows.

> *During the epidemic, we are strict with the purchasing process of food materials. The purchasing personnel are required to wear masks and disposable gloves when purchasing the food ingredients. They are also required to wash their hands, disinfect their clothing, wear masks, helmets, and disposable gloves before entering the canteen. After the purchasing work is completed, the purchasing personnel are required to wash and disinfect their hands immediately.*
>
> *Source: Interview with Mr. Qu, head chef of the canteen*

(2) Cooking process. Chefs are required to wear masks, protective caps and disposable gloves during cooking. All food must be disinfected at high temperatures.

(3) Diet menu improvement. Raw and cold food are temporarily canceled and the proportion of vegetables was increased, which could improve the immunity of employees. Poultry meat and eggs were prohibited.

Dining Activities

During the epidemic, Company C took innovative maneuvers regarding the management on employee dining activities.

(1) Packed lunch Employees had meals together in the canteen before the pandemic. If the company continues this dining model, there would be an increased risk of cross-infection. To deal with this challenge, Company C changed the dining model. The canteen packs a lunch for every employee and distributes them to the employees, which could reduce the risk of cross-infection.

(2) Dining at staggered times Employees are allowed to take packed lunches at staggering times. The specific dining time was assigned to each department.

(3) Scattered dining Employees who get the packed lunch should return to their offices and have meal at their own offices. Safe distance should be kept during dining time.

> *I think it is necessary for our company to adopt this dining method. The spread of COVID-19 pandemic is always in a diversified and hidden way, and we don't know who carries the virus. This dining method could avoid close contact among employees and inhibit the spread of the virus in the company. For example, as sale staff, we would contact many people during their business trips, when we come back to the company, we must pay more attention not to contact with other employees. Although this dining method is somewhat inconvenient, it is completely acceptable. The epidemic prevention requires everyone's joint efforts, which could benefit his/her own health as well as others' health.*
>
> *Source: Interview with Mr. Tong, staff of the marketing department*

Home Quarantine

At the beginning of China's work resumption, many enterprises experienced cluster infections and one of the reasons is that some employees returning from the most affected provinces did not receive home or centralized quarantine. Therefore, the central government of China issued the *Guidelines on measures for epidemic prevention and control for work resumption by enterprises and institutions* in February 21, requiring "the personnel returning from areas most affected by Covid-19 epidemic to receive home or centralized quarantine for medical observation." Under the guidance of national policies, Company C formulated its own home quarantine plan for its employees.

> *In view of the persistence of the epidemic, our company has implemented different home quarantine plans for different types of employees. Firstly, for the employees whose body temperature is higher than 37 degrees and those returning to Qingdao from provinces other than the epidemic epicenter provinces, they are required to receive home quarantine for 14 days before they can enter the company to work. Secondly, for the travel personnel returning to Qingdao from provinces other than the epidemic epicenter provinces, our company will subsidize them to get nucleic acid testing and receive home quarantine for 14 days before they can enter the company to work. Thirdly, for the employees returning to Qingdao from epidemic epicenter provinces, our company subsidize them to receive nucleic acid testing and let them work at home during the epidemic. All the employees staying at home are required to report their body temperature daily.*
>
> *Source: interview with Ms. Ma, head of administrative office*

DISCUSSION

In order to understand the company's experience of epidemic prevention in China, we take Company C as a typical case and obtain the practical data by field research and semi-structured interviews. In this study, we try to identify the practices Company C took to conduct epidemic prevention during work resumption. Company C's measures include the following three aspects, that is, work resumption preparation, facility and material management, and employee activity management. The research findings in this study could not only contribute to fighting COVID-19 epidemic at present, but also help the company to cope with future epidemic and other public health emergencies.

Most of Company C's measures on epidemic prevention are technical and practical aspects without political orientations, which could be applied to other countries. For instance, health education, a flexible work resumption, entry/exit management, indoor management, public place management, materials and waste management, as well as management on office/production activities, cleaning, cooking, and dining are technical measures on epidemic prevention. However, there are still some preconditions that affect what and how companies to deal with the epidemic.

The first precondition is social culture, especially the privacy standards and freedom consideration. For example, Company C requires all its employees to report their relevant information before work resumption, which covers health status, travel routes,

contact objects and so on. This measure would be accepted by East Asian countries such as China, Japan, and Singapore (34, 35), but may be considered as infringement of privacy in Western countries (36). In addition, Company C requires employees returning from the frontline of the epidemic (Hubei province) to perform home quarantine. However, forcing employees to perform home quarantine may be considered as a restriction on personal freedom in Western countries. In France, Britain, Germany and the United States, there are demonstrations against home quarantine and home isolation. Therefore, personnel information investigation and home quarantine should be treated cautiously when applying them to other countries and regions.

The second precondition is national/local OSH-regulation and temporary guideline for epidemic prevention. The epidemic prevention practices taken by Company C were based on the national OSH-regulations. In addition, the epidemic prevention practices taken by Company C were also guided by the local regulations on epidemic prevention. However, different countries have different OSH-regulations, which could provide a guideline for their companies' epidemic prevention and bring important impact on their prevention actions (37, 38). Temporary prevention guideline or suggestion issued by the government during the epidemic may also provide reference for the company's prevention practices (39, 40). These are the key factors companies need to consider for epidemic prevention.

The third precondition is at the company level, including OSH practice, resources, and physical environment. In the countries where companies have conducted OSH practice, epidemic prevention measures were not created from scratch, but are an improvement on the existing OSH program (41, 42). During COVID-19 epidemic, Company C formulated its epidemic prevention plan based on its existing OSH practices and epidemic prevention experiences from fighting SARS in 2003. Medical resources is another factor which has an important impact on a company's epidemic prevention practices, which is the basis for the epidemic prevention. Physical environment is also an important factor, which exerts a great influence on the company's epidemic prevention. The physical environment of the company may vary according to the attributes of the company. Thus, prevention measures such as environment ventilation, disinfection, physical distancing need to be implemented according to company's specific physical environment (43).

The fourth precondition is the influence of modern technology. After the outbreak of the COVID-19 epidemic, Company C scheduled new working modes, which was based on the development of modern technology, especially the emergence of technologies of telework and online communication. For instance, online meetings and remote work were introduced. In fact, the emergence of "work from home" during COVID-19 epidemic is based on IOT (Internet of Things) technologies (44, 45). Modern technologies does provide more possibilities for the company's epidemic prevention.

In terms of research design, a single-case study method is used to investigate epidemic prevention measures taken by a Chinese company in the context of COVID-19 epidemic. Although single-case study method is widely used and has been considered as applicable (46), it still cannot provide a representative picture of common practice related to the research question, and thus encounters insufficiency on producing knowledge that transcends the case in question (47). This is the common limitation of all single-case studies (48).

CONCLUSION

This paper takes Company C as a typical case, and uses field research method to summarize the practice and experience of the company's epidemic prevention and control comprehensively. Company C's measures include the following three aspects, that is, work resumption preparation, facility and material management, and employee activity management. Specifically, work resumption preparation could build a good basis for making thorough resumption and epidemic prevention plan. Facilities and material management could block the chain of epidemic spread through the physical environment. Specifically, entry/exit management could prevent the invasion of the pandemic within the company; indoor management and material and waste management could prevent cross-infection in the company. Employee activity management could block the chain of epidemic spread through the interpersonal communication. In this respect, work from home could avoid the cross-infection within the company. Also, operating management, cleaning management, cooking and dinning management could prevent cross-infection in the company. In summary, the epidemic prevention measures mentioned above cover all places in the company where the epidemic could potentially spread, and block the chain of epidemic spread from every aspect of employee activities. The research findings could shed some light on how companies in Western countries resume work and production during the COVID-19 pandemic.

PAPER CONTEXT

Promoting industry and business to resume work safely has become an important step to be taken by all countries Chinese enterprises have taken multiple measures to prevent the spread of the COVID-19 virus during work resumption. This study aimed to explore epidemic prevention measures a Chinese company (Company C) took during work resumption. The research findings could shed some light on how companies in Western countries resume work and production during the COVID-19 pandemic.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by this study received approval from the Public Management research ethics committee from Ocean University of China. The patients/participants provided their written

informed consent to participate in this study. Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

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A Mixed-Method Study on COVID-19 Prevention in Iranian Restaurants

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Background: In the face of the COVID-19, as a public health emergency, the restaurant industry is struggling to organize itself. The aim of this study is to determine the knowledge, attitude, and practice and also the perceptions of restaurants' customers and managers toward COVID-19 prevention.

Methods: This cross-sectional study was conducted using the mixed-method approach. Two online questionnaires were undertaken through WhatsApp Messenger among the 210 customers and 50 managers of restaurants. Multivariate linear regression analysis was conducted to identify the predictors of knowledge, attitude, and practice toward COVID-19 prevention. Then semi-structured, in-depth phone interviews were conducted with 45 subjects to identify their perceptions about the restaurant industry during the COVID-19 pandemic.

Results: The majority of customers had moderate knowledge (72.4%), positive attitude (90.5%), and desirable practice (38.6%); whereas the majority of managers had sufficient knowledge (50%), negative attitude (82%), and acceptable practice (58%) toward the prevention of COVID-19 in restaurants. Multiple linear regression analysis showed with increasing each 10 years in the age of the customers, the practice score significantly decreased (Beta = −0.155, $p < 0.05$). Moreover, qualitative results revealed three categories (1. restaurant industry, 2. social media, and 3. government) in 9 themes with 32 sub-themes which were explored based on the perception of the participants toward COVID-19 prevention in restaurants.

Conclusion: The majority of restaurant customers and managers have sufficient knowledge and acceptable practice, but a positive attitude among customers and a negative attitude among managers about the prevention of COVID-19 were shown. There is an urgent need to understand public awareness about preventing COVID-19 in restaurants at these critical moments. The results seek to provide strategies for the policymakers and restaurant industry to plan the specific educational intervention about how to manage future crises and public health improvement.

Keywords: Covid-19 prevention, restaurants, customers, managers, public health

INTRODUCTION

Coronavirus disease (COVID-19) outbreak was declared by the World Health Organization (WHO) on 30 January of 2020 as a Public Health Emergency of International Concern (PHEIC) (1). The virus has rapidly been spreading among people through close contact and often via small droplets produced during coughing, sneezing, or eating together (2, 3). The influence of COVID-19 falls into the actual impact of public health, supply chain, and change in what and where people want to buy their food (4). Since Iran, as one of the top 10 countries that have the highest incidence of infection, and the restaurant environment is one of the places where the disease can spread easily, assessing the level of restaurant customers' and managers' KAP and perceptions about COVID-19 can be an effective step in controlling the disease.

There is no peer-reviewed literature examining the COVID-19's ability to stay infectious on foods (5). According to the WHO reports, food contamination can occur through hands, sneezing, and coughing of workers, so proper handling is especially important if the airborne droplets carrying the virus land on ready-to-eat foods. COVID-19 is not a foodborne virus and cannot survive or thrive in food; however, the virus spreads through human contact, and cooking food at the right temperatures can inactivate the virus (1, 6, 7). Therefore, high-temperature heating of the food, preferably over 70°C that inactivates the coronavirus is very important. It has been found that the virus remains stable even at −20°C or less (8).

Moreover, the use of personal protective equipment is crucial to reducing COVID-19 viruses' transmission. Gowns and gloves are recommended as a contact precaution, and masks are recommended as a droplet precaution. It is advised to minimize the contact between people during the outbreak; therefore, online food deliveries are more desirable. These allow physical distancing between customers and sales personnel (9). However, effective infection prevention and control practices depend on the workers' awareness. A poor level of knowledge has been implicated in the rapid spread of the infection after the reopening of restaurants (10).

During the COVID-19 pandemic, widespread customers mistrust the foodservice industry, and eating out or even ordering food from their homes has been created (6). What needs to be done is a study on how the customers react in the post-COVID-19 world. As of now, it is important to make them aware that COVID-19 is not a food-borne virus. The aim of the present was to determine the knowledge, attitude, and practice of participants to reach their views for restaurant managing during the COVID-19 pandemic in order to plan the educational intervention for the target groups of restaurants' staff and the customers.

MATERIALS AND METHODS
Study Design, Population, and Data Collection

This cross-sectional study was conducted by using the mixed method approach among restaurant managers and customers (aged 20 years and above) in three phases.

Phase I

Eighty-seven restaurants from five districts (North, East, West, South, and Center) of Tehran, the capital city of Iran, were selected randomly based on the total number of restaurants in the city. The online questionnaires' link was sent to the restaurant managers to complete their questionnaire. Fifty of the managers filled out the form. Due to the fact that all the districts do not have an equal number of restaurants, a proportion to size approach has been used to select restaurants per district to reflect the variation in the number of restaurants in each district.

Online managers' questionnaire with a total of 91 scores:

- Four socio-demographic questions included age, gender, literacy, and source of information.
- Six knowledge questions with a score range of 0–6, with "True," "False," and "I Don't Know" answers. Each correct response weights 1 point and 0 for incorrect responses and "I don't know" which classifies scores as *low (0–2), moderate (2-4), and good (4-6)*.
- Five attitudes related 4 item Likert questions with the responses of *disagree, probably, agree,* and *strongly agree*. Each weighing 1–4 scores, respectively, which classify the scores as *strongly negative (<10), negative (10-15), positive (15-18), and strongly positive (18-20)*. Some questions were reversed to diminish the biases of giving a single similar response in all the items.
- Thirteen questions about the health and food safety practice of restaurant managers. Five Likert-item questions with the responses of *never, rarely, sometimes, often,* and *always*, each weighing 1–5 scores, respectively, which are classified as *weak (<30), acceptable (30–60), desirable (60–65)*.
- A single question about their need for education and how they can increase their knowledge in this subject.

Phase II

Each manager should send the second online questionnaires' link for their 10 randomly selected customers from a list of permanent customers with access to What App messenger to provide every permanent customer in each of the restaurants equal opportunity of being selected for participation. Out of the 500 customers, 253 (50.6%) responded; however, 210 (42%) of the completed questionnaires were eligible to participate in the study.

Online customers' questionnaire with a total of 45 scores:

- Five socio-demographic questions that including age, gender, occupation, literacy, and source of information.
- Eleven knowledge questions with a score range of 0–11 with "True," "False," and "I don't know" answers. Each correct response weights 1 point and 0 for incorrect responses and "I don't know," which classifies scores as *low (0–5), moderate (5-10), good (10,11)*.
- Six attitude questions related 4 items Likert with the responses of *disagree, probably, agree* and *strongly agree*, each weighing 1–4 scores, respectively, which classifies the scores as *strongly negative (<10), negative (10-15), positive (15-20), and strongly positive (20-24)*.
- Two Five Likert-item questions about the health and food safety practice with the responses of *never, rarely, sometimes,*

often, and *always,* each weighing 1–5 scores, respectively. The questions were classified as *weak (0–2), acceptable (3-6), desirable (7-10).*

There were a lockdown and social distancing of all citizens during the data collection. So in order to limit the spread of the disease, we preferred to use an online survey portal. In phase I and II, the survey instrument constituted close-ended questions and took ~15 min to complete during the period of 1–15th September 2020. The questionnaire was divided into three parts including the participants' characteristics, knowledge, attitude, and practice toward COVID-19.

Phase III

In this phase, a qualitative study was conducted using semi-structured, phone interviews with 45 subjects (15 restaurant managers, and 30 customers randomly selected from phases I and II) who were willing to participate in phone interviews. Open-ended interview questions were developed by the study authors and reviewed by an academic review panel. The question explored the participants' perceptions and demands about restaurants in the COVID-19 pandemic. The subject of the interview was about their views on restaurants, social media, and the duty of government during the COVID-19 pandemic. All of the subjects' explicit permission was sought for audiotaping. Each interview lasted from 15 to 20 min. In order to protect their identity, each participant received a coded number, which was used instead of their actual names during the data analysis. The interviews were conducted by the 3 experts in telephone interview, who had good communication. They stopped the interview once data saturation occurred (11).

The questions were "In your opinion, what are the most important challenges of restaurants' managers and customers during the COVID-19 pandemic, and what do you think about improving the situation of restaurants during these periods?" All interviews were recorded and write then final transcripts were re-read to obtain categories until themes were developed using directed content analysis and constant comparison methods. The results were further checked and confirmed by some of these key informants. All research details including procedures, actions, and decisions were documented for audit purposes (12).

Validation and Pilot Study

The questions were formulated based on the WHO and CDC guidelines and reports on COVID-19 (13). However, we adapted and modified a previously published tool for assessment of Knowledge, Attitude, and Practice (KAP) toward the prevention of respiratory tract infections (6, 14–18). Then, questions inquiring about the attitude toward preventive measures were modified to reflect the attitude and not actual practice. The preliminary phase was conducted to assess the validity and reliability of the questionnaire before using it. Initially, three experts in the field of epidemiology and nutrition and food researchers at Shahid Beheshti University of Medical Sciences were asked to evaluate the questions. Finally, six items on which disagreement among the experts was reported were removed from the final version.

Pretesting was the next step in which the last version of the questionnaire was completed by five managers and 20 customers who were excluded later from the study sample. They were asked to fill out the questionnaire twice 2 weeks apart. The collected data were used to assess internal consistency using Cronbach's alpha, as well as test-retest reliability using the intra-class correlation coefficient. The results showed adequate internal consistency and reliability (with Cronbach's alpha = 0.72 and intra-class correlation coefficient 0.96). The final questionnaire was piloted with three participates, and their comments regarding the clarity of the questions were sought. No further item was removed from the final version.

Ethical Approval

This study was approved by the Ethics Committee of National Nutrition & Food Technology Research Institute (NNFTRI), Shahid Beheshti University of Medical Sciences, Tehran, Iran (Grant No. IR.SBMU.RETECH.REC.1399.125). All respondents were guaranteed anonymity, and they provided informed consent.

Statistical Analysis

Fully completed questionnaires were extracted from Google Forms and exported to a Microsoft Excel 2016 for cleaning and coding. The cleaned data were exported to the SPSS software ver. 22. Numerical and categorical data were summarized as frequencies. Chi-square and ANOVA tests were used to determine the relationship between knowledge and attitude scores and socio-demographic variables. In the case of a significant ANOVA test, *post-hoc* analysis (LSD) was performed for multiple comparisons between each category. Multivariate linear regression analysis was conducted by using the socio-demographic variables as independent variables, and knowledge, attitude, and practice scores as the outcome variable to identify the predictors of knowledge, attitude, and practice toward the COVID-19 prevention.

After each interview of phase III, the notes were organized based on the interviews' question. All the records were transcribed verbatim and compared to the notes to fix potential discrepancies. The final transcripts were read repeatedly to achieve immersion and obtain a sense of the whole as one would read a novel. All the data relevant to each category were identified and examined using the constant comparison method (19). The emerged categories were used to organize and group the codes into meaningful themes.

RESULTS

The majority of customers were women (79.5%) and the majority of managers were men (n = 42, 84%). About 60% of the customers were under 50 years of age and 58% of the managers were 40 years old and above. Overall, 88% of the customers and 92% of the managers had a bachelor's degree and above. About half of the customers (59%) were employed. The most important source of information of all participants on COVID−19 was social media (46%) (**Table 1**).

TABLE 1 | Socio-demographic characteristics of the participants ($n = 260$).

Variables	Customers N = 210	%	Restaurant managers N = 50	%
Gender				
Male	43	20.5	42	84
Female	167	79.5	8	16
Age (year)				
20–30	33	15.8	4	8
30–40	48	22.9	17	34
40–50	41	19.5	15	30
50–60	57	27.1	10	20
60≤	31	14.8	4	8
Education				
≤Diploma	25	12	4	8
BSc degree	82	39	19	38
MSc degree	57	27.1	24	48
PhD	46	21.9	3	6
Occupation				
Unemployed	11	5.2	–	–
Housewife/houseman	41	19.5	–	–
Retired	35	16.7	–	–
Employed	123	58.6	50	100
Source of information on COVID-19				
Social media (WhatsApp, Instagram, Telegram)	96	45.7	20	40
Family/friends	9	4.3	23	46
TV and radio	59	28.1	5	10
Others*	46	21.9	2	4

Others: WHO website/CDC website/Local rules/scientific articles.

Figure 1 showed the frequency (%) of knowledge (low, moderate, and good), attitude (strongly positive, positive, negative, strongly negative), and practice (weak, acceptable, desirable) of restaurants' consumers and managers toward Covid-19 prevention. The majority of customers had moderate knowledge (72.4%), positive attitude (90.5%), and desirable practice (38.6%); whereas the majority of managers had sufficient knowledge (50%), negative attitude (82%), and acceptable practice (58%) toward the prevention of COVID-19 in restaurants. Also, 82% of them felt the urgent need for further virtual educational training in this matter.

The result of the ANOVA test showed that the mean of knowledge and attitude of customers was significantly different by educational level (**Figure 2**). The relation between education and age of the customers and their practice scores was significant, too ($P < 0.05$); however, the relation of other socio-demographic characteristics (gender, job, and source of information) was not significant. On the other hand, there was no statically significant difference in the level of knowledge and attitude scores of the managers toward COVID-19 with the socio-demographic variables. Only the practice score of the managers

was significantly related to their source of information according to the Chi-square test results ($p < 0.05$) (**Table 2**).

The multiple linear regression analysis results revealed that the main socio-economic positive predictor of knowledge and attitude toward COVID-19 prevention was the educational level of customers, whereas age was the major negative predictor of practice in them. In other word, with increasing each 10 years in the age of the customers, the practice score significantly decreased (Beta = -0.155, $p < 0.05$) (**Table 3**).

The qualitative result showed that the perceptions of customers and managers about COVID-19 prevention in restaurants are classified into three categories in 9 themes with 32 sub-themes (**Table 4**). Observance of all hygiene and sanitizing principles and guidelines completely, social distancing in restaurants, was the most frequent suggestion of the restaurant customers. Also, the majority of customers' prefer was showing all steps of food preparation on social media online. On other hand, all the restaurant managers asked the government for free tax during this time and the majority of them want the government to support COVID-19 testing for staff. They also suggested that the government hold some continuing educational webinars for restaurants' staff.

DISCUSSION

Since it is not possible to work remotely in the food industry and employees have to continue working in the former work environment, the food production chain (supply, preparation to cook, and delivery) must be operated and controlled under certain health conditions (20).

To the best of our knowledge, this is the first mixed-method study toward COVID-19 among restaurants. In this study, the majority of participants were well-educated, and overall, the rate of correct answers for the knowledge questionnaire about COVID-19 prevention in the restaurants was sufficient.

Educational status was the most important factor in improving knowledge and attitude in both groups so that with increasing the educational level, the score of knowledge was increased toward the prevention of COVID-19.

Similarly, a study in China (2020) well-confirmed revealed that there was a significant relationship between the Chinese residents' education level and the level of their knowledge about COVID-19 (21).

Since the majority of customers were < 50 years of age and well-educated and familiar with social media, this platform was the most important source of information among them toward COVID-19. Having sufficient knowledge may reflect the successful distribution of information about COVID-19 by different media. The widespread use of the Internet and its availability to wider sectors of society has made it a major source of information for the public in using this information source. Similar to our findings, other studies reported that the participants usually obtained their information about infectious diseases through the Internet and watching TV (22–24).

Another study showed that the media plays a significant role in making the public aware of hygiene measures specified by
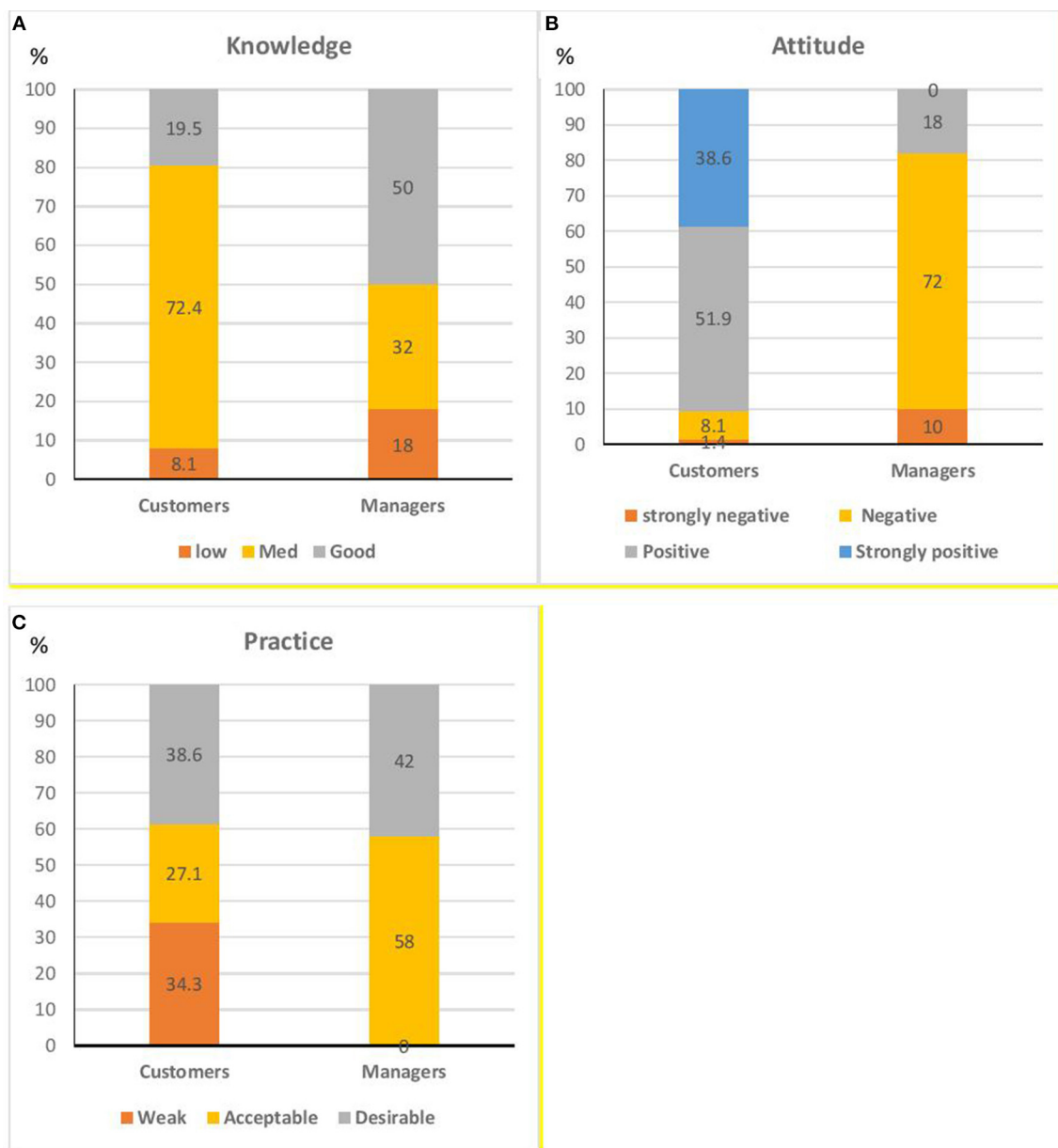
FIGURE 1 | Relative frequency of different degrees of **(A)** Knowledge, **(B)** Attitude, and **(C)** Practice of restaurants' consumers and managers toward Covid-19 prevention.

health authorities to help the pandemic. Together with customer demands for safe food, they have engendered changes in food production practices. Customers' in?uence safety practices by purchasing only from places they feel are safe, which they judge from the delivery experience, the packaging specifics, and the end product. Social media posts about restaurants' hygiene and sanitization procedures can be used strategically to develop transparency from the restaurant to the customer, as they show how the restaurant has adopted safety criteria (25).

A cross-sectional study in Bangladesh in 2020 aiming to raise awareness and attitudes among the different sections of society about COVID-19, showed that the participants' most important source of information about the COVID-19 disease was social

media (26). Nowadays, social media, in addition to being the primary source of information, is also a vehicle for news and events. During a crisis like the COVID-19 pandemic, social media should be mastered and employed responsibly. It seems that due to the important situation of this epidemic disease and given the sensitivity of the people to it, they would actively learn the knowledge of COVID-19 from various sources of information. The significant positive association between levels of education and COVID-19 knowledge shows these findings.

In the present study, although both the customers and managers had sufficient knowledge and acceptable practice, the customers' attitude was positive but the managers' attitude was negative. It seems that many factors could affect the negative
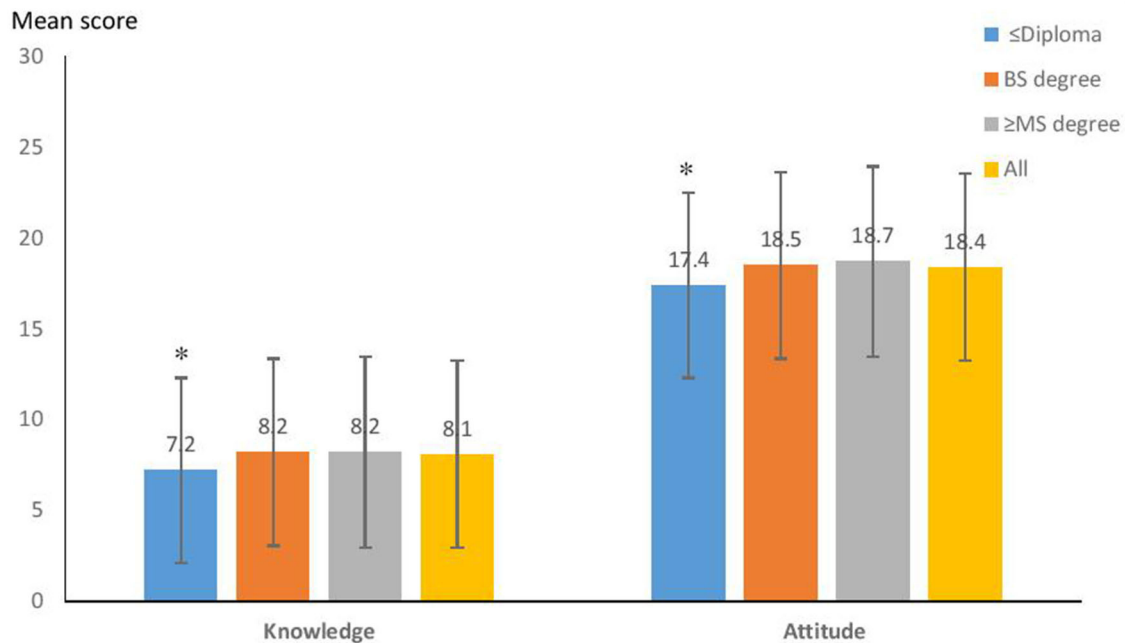
FIGURE 2 | Relation of the educational level of the customers with their knowledge and attitude scores toward the COVID-19 prevention ($n = 210$). *Statistically significant difference with other groups by ANOVA test at $P < 0.05$; Practice score was not significantly related to educational level.

TABLE 2 | Relation between the customers' age, educational level, and the managers' source of information and their practice score toward COVID-19 prevention.

Variables	Practice score			Total
	Weak	**Acceptable**	**Desirable**	
Education*				
≤ Diploma	7 (28)	15 (60)	3 (12)	25 (100)
BS degree	28 (34.1)	23 (28)	31 (37.8)	82 (100)
≥ MS degree	37 (35.9)	19 (18.5)	47 (45.6)	103 (100)
Age*				
20–30	13 (39.7)	3 (9.1)	17 (51.5)	33 (100)
30–40	15 (31.3)	1 (2.1)	32 (66.7)	48 (100)
40–50	21 (51.2)	6 (14.6)	14 (34.1)	41 (100)
50–60	12 (21.1)	30 (52.6)	15 (26.3)	57 (100)
60≤	11 (35.5)	17 (54.8)	3 (9.7)	31 (100)
Total	72 (34.3)	57 (27.1)	81 (38.6)	210 (100)
Source of information**				
Social media	0	10 (50)	10 (50)	20 (100)
Family & friends	0	17 (73.9)	6 (26.1)	23 (100)
TV & radio	0	0	50 (100)	5 (100)
Others[†]	0	2 (100)	0	2 (100)
Total	0	29 (58)	21 (42)	50 (100)

*Statistically significant by χ^2 at $P < 0.05$. Other socio-demographic characteristic (sex, job, and the source of information) was not significantly associated with consumers' practice scores.
**The practice score of managers was significantly related to their source of information by χ^2 at $P < 0.05$. Other socio-demographic characteristic (age, education, sex, and job) was not significantly associated with managers' practice scores.
[†] Others: WHO website/CDC website/Local rules/scientific articles.

TABLE 3 | Socio-economic predictors of knowledge, attitude and practice of customers toward the COVID-19 prevention.

Relation to socio-economic predictors		B	Standard error	Beta	P-value
Knowledge	Education	0.273	0.127	0.168	0.032*
	Job	0.074	0.128	0.044	0.567
	Gender	−0.272	0.273	−0.069	0.319
	Age	−0.010	0.084	−0.009	0.902
Attitude	Education	0.490	0.235	0.164	0.039*
	Job	−0.092	0.238	−0.030	0.699
	Gender	−0.180	0.507	−0.025	0.722
	Age	0.221	0.156	0.099	0.158
Practice	Education	0.050	0.068	0.057	0.466
	Job	−0.004	0.069	−0.005	0.949
	Gender	−0.107	0.147	−0.051	0.468
	Age	−0.101	0.045	−0.155	0.028*

*Statistically significant by multiple linear regression analysis at $P < 0.05$.

TABLE 4 | The most important concepts extracted from consumers and managers perceptions on the restaurant industry during COVID-19 pandemic.

Category	Theme	Sub-theme	
		Customers	Restaurant manager
Restaurant industry	Personal Hygiene	• Observance of complete hygiene and principles, according to the protocols for staffs • Restaurants should open with a half of the restaurants' capacity for social distance	• Observing the constant hygiene of each staff and customer • Maintaining environmental hygiene • Observance of 2 meters distance in the restaurants
	Environment hygiene	• Disinfect tables and chairs • Sanitizing toilet	• Disinfect all equipment • Digital payment
	Food hygiene	• Observing food hygiene specially in raw food • Serving the meal in the heaters on the tables • Keeping the plates, spoons, and forks warm on the tables	• Serving well-cooked foods • Using disposable and packaged containers
	Delivering	• Online food deliveries are more desirable • Observing the personal hygiene for delivery drivers • Restaurants should insert the label of reheating on the food packages	• Disinfecting the final package before delivery
Social media	Advantages	• Restaurants can show all the steps of food preparation on the website	• Keep posting information on social media platforms
	Disadvantage	• Infodemic and disinformation • Fake advertisements	• Disinformation • Unreal advertisements against restaurants
Government	Restaurant inspection	• Continuous online monitoring by Ministry of Health and Medical Education • Quick handling of consumer complaints	• Serious audit and inspection by the Union. • Correct and strict screening
	Funding	• The government should provide funding for restaurants being equipped	• Free tax during this time • Support COVID-19 testing for staffs
	Education	• Sending educational health messages	• Holding educational webinars

attitude of them. One of the important factors can be the locking down of the restaurants during this time and another factor is, after the reopening permission of the restaurants, the customers were afraid of going to eat there or even order food to be sent to their home because they were not uncertain about the restaurants' condition with regard to spreading COVID-19. Finally, economic problems that the restaurant industry suffered during this period have a negative impact on the attitude of restaurant managers, probably because they are responsible for their staffs and customers, and also they were responsible for paying employees' salary in case of illness (COVID-19 Positive) with the limited support of the government.

Based on the customers' important views there would be more confidence among them in going to or ordering food from the restaurants, if the restaurants observe all the hygiene and sanitizing principles as well as the protocols issued by the health authorities, including wearing a mask by the staffs, performing social distancing. A study in China in 2020 indicated that observing personal hygiene by staff involved in food handling was of great importance to all food-related centers.

COVID-19 positive people should not be allowed to be present in food-related environments. The COVID-19 disease can be asymptomatic in the early stages, meaning that asymptomatic staffs may actively transmit the virus to food and food-handling surfaces [14].

Another view was that they should only deliver food with online ordering and they should insert the label of reheating on the food packages.

Also, the customers suggested online monitoring is required by the Ministry of Health and Medical Education. It seems that, reminding the customers that all the principles based on the standard health protocols have been met in social media can increase the customers' trust during the COVID-19 pandemic.

Restaurant managers believed that serious inspections are required by the Union. In addition, the majority of restaurant managers expected the government to provide virtual training for the restaurant staff. However, as the results showed, their attitude toward COVID-19 has been negative and it seems that they need specific training courses for updating their information in this regard. The findings of a study in China in 2020 showed that advanced training courses and special attention could lead to raising knowledge and attitude [27].

To promote and develop the equipment and sustain safety steps (such as digital menus, digital thermometers, no-touch-hand sanitizer, hotboxes for delivering, using robots instead of waitress, and automatic serving), governmental financial support is needed.

The managers believed that the government should support COVID-19 testing for the restaurant staff. It seems that, due to the high price of testing, they are not inclined to do such tests, until symptoms appear.

Most managers appear resistant to make changes to the way of cooking, packaging, delivery, which could be due to the economic shock for this industry. Economic fears have negative impact on managers' creativity and innovation at this time. The restaurant industry will have to re-create itself as an appropriate strategy for surviving in this time and post COVID days.

Totally, the restaurant industry should prepare for future crises. The managers must follow all instructions issued by the authorities and that they have to reduce workplace risk to the lowest reasonably practicable level by taking preventative measures. Responsible managers will join with their governments' fight against COVID-19 by working with their sector bodies to protect their workers and the customers. Additionally, inspectors should carry out compliance checks nationwide to ensure that employers are taking the necessary steps.

Based on the United Kingdom's COVID-19 secure guidance for managers and staff, the managers should make sure that the risk assessment for their business addresses the risks of COVID-19, and the employers and workers should always come together to resolve issues [28].

The National Academy of Sciences defines resilience as "the ability to plan and prepare for, absorb, recover from, and adapt to adverse events." Creating these four sections that can provide insights into how restaurants are responding to the pandemic in terms of food safety and the public health involved, workers, and customers [29].

Also, the governments should support the restaurant managers to increase their staffs' knowledge and attitude by online intensive update courses that can lead to desirable practice for the prevention of COVID-19 in the community. Therefore, the results of this study can be useful for the restaurant industry to create new ways and planning for future educational intervention to help for breaking the cycle of COVID-19 in the communities.

LIMITATIONS

The main limitation is the speed at which general knowledge both changes and grows in relation to what the general public knows about the transmission of COVID-19 which has changed the context in which the survey work was done compared to today. Due to the long duration of the COVID-19 pandemic, the majority of the restaurants were closed and the most of managers were not willing to cooperate with this study, so the sample size of managers was limited. Moreover, the response rate of 50% also limits the generalizability of the result.

CONCLUSION

The majority of restaurant customers and managers have sufficient knowledge and acceptable practice, but positive attitude among customers and negative attitude among managers about the prevention of COVID-19 was shown.

Social media has the main role and responsibility in increasing the community's information during the COVID-19 crisis. The authorities should provide a guideline for the restaurants for the prevention of the COVID-19 disease. It is an urgent need for training programs to improve the understanding of the risks and prevention strategies among the restaurant managers and public awareness and also specific educational intervention by the government and stakeholders for crises and public health improvement.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

ETHICS STATEMENT

This study was approved by the Ethics Committee of National Nutrition & Food Technology Research Institute (NNFTRI), Shahid Beheshti University of Medical Sciences, Tehran, Iran (Grant No. IR.SBMU.RETECH.REC.1399.125). All respondents were guaranteed anonymity, and they provided informed consent.

AUTHOR CONTRIBUTIONS

FE: concept, design, statistical analysis, and supervision. YS: acquisition, analysis, and interpretation of data. FE, YS, and FM-N: drafting of the manuscript. FM-N and NB: critical

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Correlation of Demographics, Healthcare Availability, and COVID-19 Outcome: Indonesian Ecological Study

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Objective: To analyze the correlation between demographic and healthcare availability indicators with COVID-19 outcome among Indonesian provinces.

Methods: We employed an ecological study design to study the correlation between demographics, healthcare availability, and COVID-19 indicators. Demographic and healthcare indicators were obtained from the Indonesian Health Profile of 2019 by the Ministry of Health while COVID-19 indicators were obtained from the Indonesian COVID-19 website in August 31st 2020. Non-parametric correlation and multivariate regression analyses were conducted with IBM SPSS 23.0.

Results: We found the number of confirmed cases and case growth to be significantly correlated with demographic indicators, especially with distribution of age groups. Confirmed cases and case growth was significantly correlated ($p < 0.05$) with population density (correlation coefficient of 0.461 and 0.491) and proportion of young people (-0.377; -0.394). Incidence and incidence growth were correlated with ratios of GPs (0.426; 0.534), hospitals (0.376; 0.431), primary care clinics (0.423; 0.424), and hospital beds (0.472; 0.599) per capita. For mortality, case fatality rate (CFR) was correlated with population density (0.390) whereas mortality rate was correlated with ratio of hospital beds (0.387). Multivariate analyses found confirmed case independently associated with population density (β of 0.638) and demographic structure (-0.289). Case growth was independently associated with density (0.763). Incidence growth was independently associated with hospital bed ratio (0.486).

Conclusion: Pre-existing inequality of healthcare availability correlates with current reported incidence and mortality rate of COVID-19. Lack of healthcare availability in some provinces may have resulted in artificially low numbers of cases being diagnosed, lower demands for COVID-19 tests, and eventually lower case-findings.

Keywords: COVID-19, demographic, healthcare availability, Indonesia, ecological study

INTRODUCTION

The end of August 2020 marked the 6th month of the COVID-19 pandemic in Indonesia. Since the first confirmed case was announced in March 2020, there has been 177,571 confirmed cases, with 69,195 occurring in August alone. At the same time, there has been 7,505 mortalities with the nationwide case fatality rate from COVID-19 at 4.2% (1).

Looking closer into the distribution of these cases and mortalities, we can start to see disparities between Indonesian provinces. Disparities in health outcomes between provinces is not new in Indonesia (2), an island nation comprised of more than 17,000 islands divided into 34 provinces.

Studies have been conducted into this inequality and formulated into a public health inequality index (PHDI), which reported wide variation among Indonesian provinces, including in the healthcare provision sub-index (3). Inequality was also observed on social determinants of health, such as socioeconomic status and basic demography (2, 4).

Similar ecological studies showed that areas with lower socioeconomic status were related with higher rates of COVID-19 transmission, as well as mortality (5, 6). These results were also replicated in population-based studies (7, 8). However, few of these studies discussed how the inequality of healthcare resources and access potentially contribute to these correlations, despite previous evidence on the association between low socioeconomic income and lower healthcare access (9, 10).

In 2020, faced with a novel and global pandemic, inequality in demography and healthcare availability among provinces may contribute to different public health approaches in mitigating the pandemic and its eventual outcome (11). Other studies have reported how geographic inequalities, including socioeconomic and demographic ones, affect the COVID-19 spread rate (12, 13).

Six months into the pandemic seems to be a good time to begin evaluation on how pre-existing inequality affects the preliminary outcome of the COVID-19 pandemic mitigation in Indonesia. Thus, this study aims to explore the association between pre-existing demographics and healthcare availability variation with the current COVID-19 pandemic among Indonesian provinces.

MATERIALS AND METHODS

Study Design

We conducted an ecological study using pre-published data on Indonesian demographic and healthcare availability. Data on demographic and healthcare availability indicators were obtained from the Indonesian Health Profile of 2019 from the Indonesian Ministry of Health website, which can be accessed from https://pusdatin.kemkes.go.id/folder/view/01/structure-publikasi-data-pusat-data-dan-informasi.html. It was an annual report on the state of the Indonesian health system, including its determinants, capacities, and outcomes (14). Meanwhile data related to the COVID-19 pandemic development in Indonesia was obtained directly from the daily updated web page of the Indonesian Task Force on COVID-19, which can be accessed from https://covid19.go.id/peta-sebaran (1). All data was collected for all 34 Indonesian provinces, with detail on 10 provinces in Sumatra

and its surrounding isles, six provinces in Java, five provinces in Kalimantan (Borneo), six provinces in Sulawesi (Celebes), three provinces in Lesser Sunda Isles, and two provinces each in Maluku Isles and Papua.

Data Collection

We collected data on demographics, healthcare availability, and COVID-19 indicators from the aforementioned data sources. Demographic indicators used in this study include population density, demographic structure, percentage of young, productive age, and elderly population), and people living under poverty. Young age was defined as those under 15 years old, productive age were 15–65 years old, and the elderly were over 65 years old. These indicators meant to reflect population connectedness, the distribution of at-risk groups, and the socioeconomic susceptibility of each province. These indicators were selected to be analyzed due to previous evidence on COVID-19 infection distribution based on age group and socioeconomic status (7, 15–17).

Health availability indicators included in this study were the ratio of general practitioners, primary care clinics, hospitals, and hospital beds. All these indicators were calculated by dividing the published number of general practitioners, primary care clinics, hospitals, and hospital beds by population size for each province, displayed as units available for 100,000 residents for general practitioners, primary care clinics, and hospitals, and units available for 1,000 residents for hospital beds. For context, primary care clinics in Indonesia include clinics, private general practitioner practices, public health centers, and basic hospital registered primary care providers in partnership with the Indonesian single payer health system. General practitioners and primary care ratios were meant to reflect provincial primary healthcare availability while hospital and hospital bed ratios were meant to reflect secondary and tertiary care availability.

COVID-19-related indicators were classified into case-finding indicators and mortality indicators. Case finding indicators include confirmed cases and daily case growth. COVID-19 cases in Indonesia are defined according to the Indonesian Ministry of Health regulation, itself referring to the WHO's recommendations, which require confirmation by nucleic acid amplification by RT-PCR procedure (18). Case growth was defined as the number of new confirmed cases found daily. Case-finding indicators also include incidence and daily incidence growth, defined as confirmed cases and case growth weighted with provincial population size.

COVID-19 mortality indicators include case fatality rate (CFR) and mortality rate. CFR was defined as percentage of mortality among confirmed cases, whereas mortality rate was confirmed COVID-19 mortality per population size.

All data on cross-sectional COVID-19 indicators (incidence, CFR, and mortality rate) were obtained on 31st August 2020. Meanwhile, for longitudinal indicators (daily case growth and incidence growth), data were collected since national case reached 100,000 on the 27th July 2020. This starting point was selected to give a more equal starting point between provinces as first reported cases and initial case-finding efforts may have differed. By this point, all Indonesian provinces had reported

confirmed COVID-19 cases in their territory, a milestone passed on the 9th of April 2020.

Data Analysis

We conducted correlation analyses between demographics, healthcare availability, and COVID-19 outcome indicators. Parametric Pearson and non-parametric Spearman correlation was conducted based on a normality test (Shapiro-Wilk) result. All analyses were performed using IBM SPSS 23.0. Statistical significance cut off was determined at $p < 0.05$. We also conducted multivariate linear regression for variables with $p < 0.25$.

Ethical Statement

This study analyzed deidentified publicly available data and as such was exempt from Udayana University Ethical Committee reviews.

RESULTS

We found wide variation between all indicators among Indonesian provinces. Based on Shapiro-Wilk test, all data were found with non-normal distribution, except for percentages of young and productive age populations, as well as the ratios for hospitals and hospital beds. Thus, all data were displayed in median with variance displayed as minimum and maximum values for each measure (**Table 1**).

Especially wide variation was found with population density, which reflects the disparity of population concentration in Indonesia, which is concentrated on the western region, especially in provinces located in Java (six provinces) and Sumatra (10 provinces). Around 56.35% of the Indonesian population live on Java Island, which constitutes around 6.23% of her total land area. The heavily urbanized special capital region of Jakarta alone represents 3.94% of the Indonesian population, with only 0.04% of its total land area. Provinces in the western region of Indonesia also tend to have more favorable socioeconomic and healthcare availability indicators. DKI Jakarta was found to have the least poverty (3.47%) and highest availability of primary care, as well as tertiary care, with 59.49 general practitioners per 100,000 residents and 2.24 beds per 1,000 residents.

Wide variation was also found in COVID-19 indicators, both case-finding and morality related indicators. As an example, confirmed cases ranged from 177 cases in East Nusa Tenggara to 40,086 cases in Jakarta while CFR ranged from 0.52% in North Kalimantan to 7.29% in Bengkulu. Wide variation persisted after weighting by population size, which may be attributed to the aforementioned fact that population size and density also varied widely among Indonesian provinces.

Correlation analyses were then performed with a non-parametric Spearman correlation test, as all COVID-19 indicators were found to have non-normal distribution when using the Shapiro-Wilk test. Correlation results are displayed in **Tables 2**, **3**.

Absolute count of confirmed cases and case growth were found to be correlated with demographic indicators. Both

TABLE 1 | Description of median values for all indicators.

Variable	Median (IQR)
Demographic	
Population density	103.42 people/km^2 (46.85 – 249.74)
Proportion of young resident	27.94% (26.53 – 29.81)
Proportion of productive age resident	67.67% (65.45 – 68.88)
Proportion of elderly resident	4.58% (3.75 – 5.54)
Residents living under poverty line	8.76% (6.30 – 13.75)
Healthcare availability	
Ratio of general practitioner	19.74 GPs/100,000 residents (16.11 – 26.38)
Ratio of primary care clinic	10.78 clinics/100,000 residents (8.77 – 14.91)
Ratio of hospital	1.08 hospitals/100,000 residents (0.82 – 1.31)
Ratio of hospital beds	1.21 beds/1,000 residents (1.03 – 1.53)
COVID-19 case-finding	
Confirmed case	1,950.50 cases (582.50 – 4,642.25)
Case growth	25.36 cases per day (7.24 – 61.01)
Incidence	49.31 cases/100,000 residents (22.45 – 112.76)
Incidence growth	0.66 cases/100,000 residents/day (0.28 – 1.03)
COVID-19 mortality	
Case fatality rate	3.00% (1.74 – 4.10)
Mortality rate	1.31 deaths/100,000 residents (0.50 – 4.00)

TABLE 2 | Correlation coefficient between demographics and healthcare availability with COVID-19 case-finding indicators.

Variable	Confirmed case	Case growth	Incidence	Incidence growth
Demographic				
Population density	0.461**	0.491**	−0.033	−0.006
Proportion of young resident	−0.377*	−0.394*	−0.114	−0.114
Proportion of productive age resident	0.288+	0.291+	0.211	0.228
Proportion of elderly resident	0.283	0.288+	−0.058	−0.089
Residents living under poverty line	−0.293+	−0.303+	−0.189	−0.197
Healthcare availability				
Ratio of general practitioner	0.049	0.173	0.426*	0.534**
Ratio of primary care clinic	−0.207	−0.238	0.423*	0.424*
Ratio of hospital	−0.196	−0.160	0.376*	0.431*
Ratio of hospital beds	0.172	0.284	0.472**	0.559**

$^+p < 0.1$; $^*p < 0.05$; $^{**}p < 0.01$.

measures were significantly correlated with population density. Both were also found with significant inverse correlations with the proportion of residents aged < 15 years. Both measures were also correlated with almost all other demographic indicators, although with p-value higher than the statistical significance

TABLE 3 | Correlation coefficient between demographics and healthcare availability with COVID-19 mortality indicators.

Variable	Case fatality rate	Mortality rate
Demographic		
Population density	0.390*	0.183
Proportion of young resident	−0.244	−0.233
Proportion of productive age resident	0.097	0.239
Proportion of elderly resident	0.180	0.066
Residents living under poverty line	0.002	−0.150
Healthcare availability		
Ratio of general practitioner	0.003	0.310[+]
Ratio of primary care clinic	−0.180	0.212
Ratio of hospital	−0.300[+]	0.154
Ratio of hospital beds	0.022	0.387*

[+]$p < 0.1$; *$p < 0.05$.

threshold of 0.05. Population-weighted case-finding indicators, meanwhile, were correlated with healthcare availability. Both incidence and incidence growth were significantly correlated with ratios of general practitioners, hospitals, and hospital beds per capita.

Similar dynamics can be observed in COVID-19 mortality indicators. CFR was significantly correlated with population density and was found to have a statistically weaker correlation with hospitals per capita ratio. Meanwhile, population-weighted mortality rate indicator was not correlated with any demographic indicators, but rather was correlated with the ratio of hospital beds per capita and had a statistically weaker correlation with the ratio of general practitioners.

We conducted multivariate regression analyses for variables with $p < 0.25$ in bivariate correlation analysis. When more than one of the demographic structure indicators (proportion of population based on age groups) were eligible for multivariate analyses, only one of them would be analyzed due to the collinearity of these variables. Consequently, the strongest correlate (highest correlation coefficient) would be included in multivariate analyses while the others were excluded. Standardized coefficients (β) from regression analyses were depicted in **Table 4**.

The results bear similarity with bivariate correlation analyses. Population density and demographic structure were independently associated with confirmed cases whereas case growth was only independently associated with population density. When controlling for population size, no variable was independently associated with incidence, however, hospital bed ratio was independently associated with incidence growth. No variables were independently and significantly associated with mortality.

DISCUSSIONS

We observed a bivariate correlation between demographics, healthcare availability, and COVID-19 indicators. A correlation was observed between confirmed case count and case growth

with demographic indicators that may suggest that demographic structure is indeed the main determinant of COVID-19 distribution in Indonesia. The direction of these correlations seems to be in line with what we know of COVID-19 distribution among age groups.

Interestingly, the correlation seemed to shift from demographics to healthcare availability when COVID-19 indicators analyzed were controlled for population size, for example from total case to incidence. This trend also persists in multivariate analysis although the strength of correlation, and statistical significance.

Provinces with a high proportion of young people were found to have fewer cases and lower-case growth, while the proportion of productive and elderly populations is positively correlated with both measures, as depicted in **Figure 1**. This pattern of COVID-19 case distribution by age has been previously described [19] and also corroborated by Indonesian national data [1]. Similar correlations have also been reported in an ecological study investigating spread rate in Northern Italy [12].

However, in our context there has been insufficient published data on the distribution of COVID-19 suspects and tests performed by age group. Public health measures implemented early in the pandemic in Indonesia suspended in-person school activities, which may limit contact with infectious people, limiting transmission. Another possibility is that children are less likely to be tested. Indeed, symptoms in children tend to be milder, which may mean that cases are misdiagnosed as other illnesses and children are not tested for COVID-19 [20].

Meanwhile, the correlation between incidence and ratio of general practitioners and beds per capita, respectively representing availability of primary and tertiary healthcare, indicates a different aspect of case detection than a simple lack of test rate. Healthcare visits, which are predisposed by healthcare availability [21], are necessary to diagnose patients as suspects of COVID-19, requiring further tests. This inequality of primary and tertiary healthcare availability comes hand in hand with testing capacity inequality. **Supplementary Table 2** depicts the correlation between national referral laboratories for COVID-19 tests with primary and tertiary healthcare availability. Lack of healthcare availability would then exacerbate the problem of inadequate tests by creating an artificially low demand for COVID-19 tests, referring to the inadequate number of laboratories to perform those tests.

This result seems to corroborate suspicion that Indonesian COVID-19 data was attributed, partly, to inadequate case-finding effort. Case in point is how the current trend did not fit the earlier forecast trajectory for COVID-19 case growth despite inadequate enforcement of health protocols in some provinces [22–24].

As of the writing of this article, Indonesia has not been able to fulfill this criterion. In the last week of August 2020, daily COVID-19 test rates for suspected cases ranged from 10,000 to 20,000 tests a day, in a country with more than 260 million residents [25], much lower than the WHO recommended level of one suspected case per 1,000 population per week [26]. While national referral laboratories for COVID-19 diagnosis tripled between May and July 2020 [27, 28], it still only represent <1 laboratory per 1 million residents nationwide, or a median

TABLE 4 | Standardized coefficient (β) for multivariate linear regression between demographics and healthcare availability with COVID-19 outcome indicators.

Variable	Case finding				Mortality	
	Confirmed case	Case growth	Incidence	Incidence growth	Case fatality rate	Mortality rate
Demographic						
Population density	0.638**	0.763**	N/A	N/A	−0.052	N/A
Proportion of young resident	−0.289*	−0.218[+]	N/A	N/A	−0.313[+]	N/A
Proportion of productive age resident	N/A	N/A	0.022	0.004	N/A	0.125
Residents living under poverty line	0.069	0.037	N/A	N/A	N/A	N/A
Healthcare availability						
Ratio of general practitioner	N/A	N/A	0.411	0.431[+]	N/A	0.116
Ratio of primary care clinic	−0.136	−0.102	0.259	0.129	N/A	−0.093
Ratio of hospital	N/A	N/A	−0.349	−0.330	−0.291[+]	N/A
Ratio of hospital beds	N/A	−0.009	0.399	0.486*	N/A	0.370

[+]$p < 0.1$; *$p < 0.05$; **$p < 0.01$.

provincial ratio of 0.84 laboratories per 1 million residents (**Supplementary Table 1**).

It further suggests that lack of reported COVID-19 cases in certain provinces can be attributed to an inequality of healthcare resources, both in personnel and capital investments. This condition predates the current pandemic (29) but has since became more apparent. It is further corroborated with a positive correlation between hospital beds and mortality, which indicates that a number of COVID-19 deaths may be unaccountable due to a lack of healthcare access.

We have had evidence on how inequalities affect outcomes of COVID-19. Population-based studies have reported how different age groups have different susceptibilities to transmission, either due to biologic or behavioral factors (30, 31). Poverty has also been reported to correlate with mobility and transmission (32) and lack of healthcare access has also been reported to correlate with mortality (33). Meanwhile, other studies have reported how geographical inequality leads to different COVID-19 spread and mortality outcomes (34).

However, correlation on an ecological level is frustrated by the disparity of data quality for COVID-19 indicators. A similarly peculiar pattern occurred where developed countries seemed to fare worse in COVID-19 indicators than had been previously reported (35, 36). Lack of detection availability, including low test rate, as well as alleged data manipulation by authorities has been cited as possible explanations behind these results (35).

Another interesting finding in our results is a negative correlation between poverty with confirmed case numbers and growth. This differs from previous data, both from population-based research and ecological data, which found a positive correlation between poverty and COVID-19 spread in a population (32, 37).

In an Indonesian context, there are a number of COVID-19 tests conducted by private clinics funded out-of-pocket by patients. People took these tests if they were ineligible for publicly funded COVID-19 tests or they deemed the waiting list for publicly funded tests to be too long. In this condition, residents in provinces with high poverty may be less capable of affording out-of-pocket healthcare, and thus are less likely be properly diagnosed or to afford out-of-pocket tests. Indeed, observers have reported on the unequal access to COVID-19 tests in Indonesia between different socioeconomic classes (38). However, there are insufficient data on how much these out-of-pocket tests contribute to the number of tests performed in Indonesia or in each province.

All these findings suggest that pre-existing demographics and healthcare availability in Indonesia hinders an effective response to the COVID-19 pandemic in a very basic way: it prevents policymakers from detecting the real gravity of the situation. Capacity-building efforts initiated over the course of the pandemic is much too focused on building testing capacity without much effort to build up the underlying inequality of healthcare availability. Even then, testing capacity build-up is still inadequate and needs to be accelerated.

The policy implications of these findings concern Indonesia's preparedness for future pandemics. Equalization of healthcare availability would allow policymakers to detect health problems earlier, including future outbreaks, epidemics, and even pandemics. It has been noted in another analysis of COVID-19 spread in Indonesia that increased detection capacity always led to surges in new cases, suggesting detection capacity at baseline was inadequate (39). To rectify this issue, policymakers should prioritize equalization of healthcare availability throughout the archipelago.

Limitations of Tools and Data

We must address the validity of data from both our sources. Non-uniform eligibility for publicly funded tests between Indonesian provinces and regencies may lead to unaccounted variations in COVID-19 indicators. Regardless of an official guideline, reality in the field may be different and unaccounted for in official reports used in this study.

Data collection methods for these data sources should also be addressed. As Indonesian public agencies usually relied on bureaucratic multilevel tabulation for data gathering, there was a chance that data collected in the national level (e.g., the ones we utilized for this analysis) were not the most up-to-date version

FIGURE 1 | Scatter plot depicting a correlation between general practitioners and hospital beds per population, representing primary, and tertiary healthcare availability, with incidence **(A,B)**, incidence growth **(C,D)**, and mortality rate **(E,F)**.
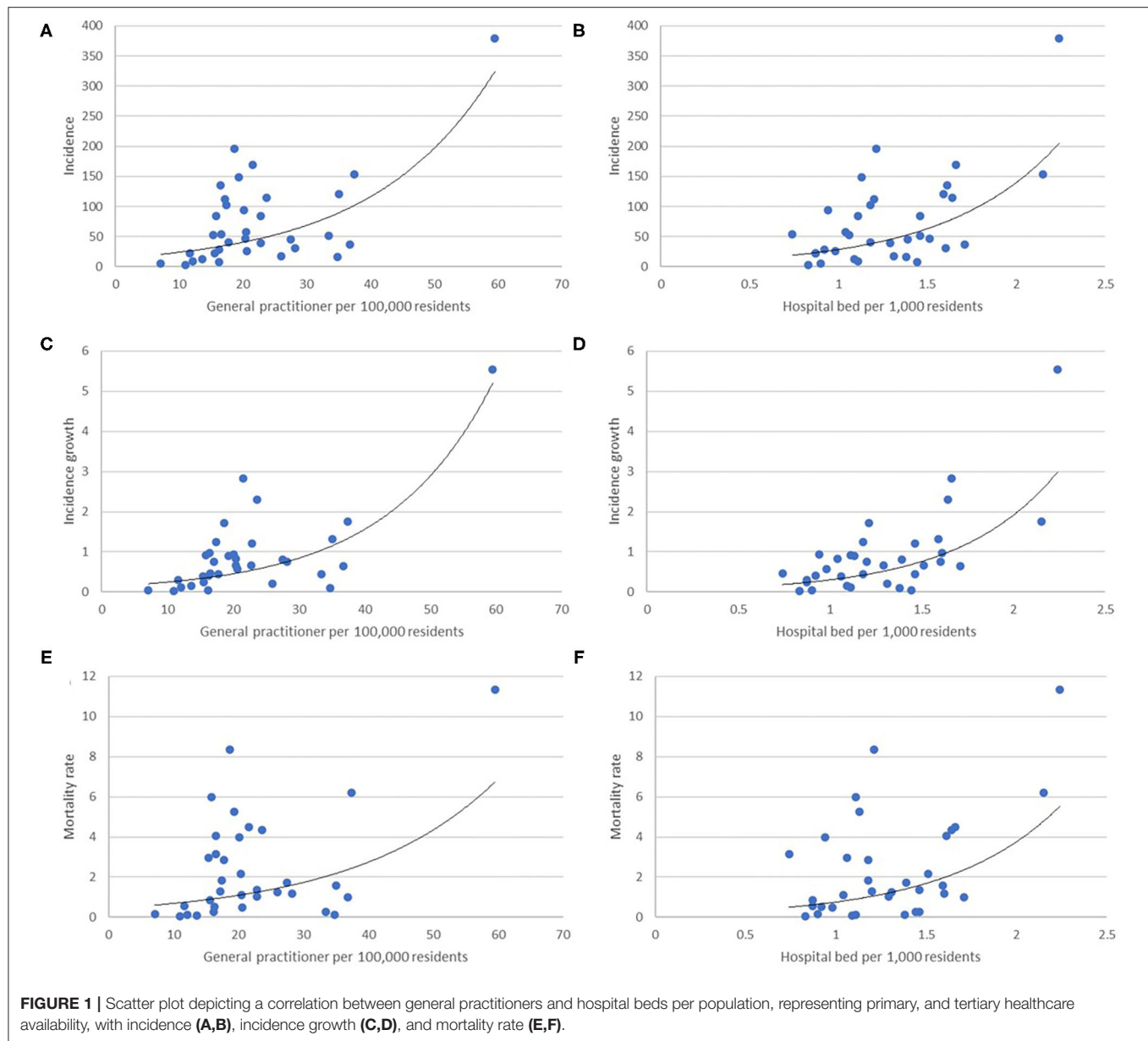
and did not accurately reflect the situation in the field. Indeed, observers have commented on discrepancies between national and district level data on COVID-19 (40) and inadequate data transparency (41). However, for the purposes of this analysis we believe it was a minor issue as the discrepancy was spread throughout the provinces.

Although multivariate analyses were performed, our study is limited in scope and scale as we only analyzed certain variable groups in association with COVID-19 outcomes with limited numbers of repetition (i.e., Indonesia's 34 provinces). Complex situations such as COVID-19 outcome may be associated with a multitude of other determinants which this study did not account for.

Our analysis may also be subject to fallacies related to drawing conclusions from ecological data. As such, population-based

studies should be conducted to test the notion that the lack of healthcare access may affect the outcomes of COVID-19, from late diagnosis, late treatment, to increased risk of morbidity and mortality.

CONCLUSIONS

We found a correlation between demographics with COVID case-findings and CFR indicators. However, controlling for population size revealed that COVID-19 incidence and mortality rate variations between Indonesian provinces to be more strongly correlated with healthcare availability in Indonesia, both at primary and tertiary levels.

Our findings corroborate the long-held suspicion that the current reported indicators of the COVID-19

situation may not reflect the real situation. Inequality in healthcare availability, which predates the current pandemic, is suggested to be a stronger determinant for the reported state of the pandemic than demographics. It put the problem in evaluating the COVID-19 situation in Indonesia to be deeper than a simple build-up of testing availability.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/**Supplementary Material**, further inquiries can be directed to the corresponding author/s.

AUTHOR CONTRIBUTIONS

GW was responsible for conceptualization, data curation, analysis, methodology, and writing of the initial draft. PJ contributed to the writing, review, and editing process. All authors contributed to the article and approved the submitted version.

SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpubh.2021.605290/full#supplementary-material

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Mental Health of Physicians During COVID-19 Outbreak in Bangladesh: A Web-Based Cross-Sectional Survey

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There have been numerous studies about the health implication of COVID-19 on patients, but little attention has been paid to the impacts of the pandemic on physicians. Our paper attends to this gap by exploring the mental health of physicians in Bangladesh during the COVID-19 pandemic. This is particularly important since the mental health of physicians impacts not only on themselves, but also their professional performance and hence the care of patients. This study examined physicians' mental health outcomes by evaluating the prevalence and associated potential risk factors of anxiety and depression. Using a web-based cross-sectional survey, we collected data from 114 physicians. Seven-item Generalized Anxiety Disorder (GAD-7) scale and Nine-item Patient Health Questionnaire (PHQ-9) were used to measure the anxiety and depression, respectively. Multivariate logistic regression models were used to explore the potential risk factors related to anxiety and depression. The prevalence of anxiety and depression were 32.5 and 34.2%, respectively. Findings revealed that marital status, work per day and current job location were the main risk factors for anxiety while sex, age, and marital status were the main risk factors for depression. Our results highlight the need to implement policies and strategies for positively impacting the mental health of physicians during and after the COVID-19 pandemic.

Keywords: COVID-19, depression, anxiety, physicians, Bangladesh

INTRODUCTION

The coronavirus disease 2019 (COVID-19) outbreak has been declared as a pandemic resulting global health concern (1). The infectious disease is responsible for acute respiratory illness caused by the newly discovered severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). It was first detected in Wuhan, China at the end of December 2019 (2), and has become an increasingly public event around the world including Bangladesh (3, 4).

As of July 22, 2020, 14,731,563 confirmed cases of COVID-19 including 611,284 deaths have been reported by WHO globally (5). In Bangladesh, the first known cases were reported on March 7, 2020 by the country's epidemiology institute IEDCR (Institute of Epidemiology, Disease Control and Research) (6). As of July 22, 2020, a total of 213,254 COVID-19 confirmed cases and 2,751 deaths have been reported in Bangladesh (7).

The coronavirus spreads primarily through droplets of saliva and discharges from the nose and mouth when a COVID-19 patient coughs or sneezes (8). Still no effective treatment is available of COVID-19, although many accomplishments including virus information, clinical features, and diagnosis have been achieved (2, 9–11). Physicians are first-line responders treating patients with COVID-19 and face a high risk of being infected because of exposure to long and distressing work-shifts to meet health requirements every day (12).

Some hospitals in Bangladesh have been completely converted into COVID-19 centers and some others have opened a dedicated COVID-19 special unit or ward. Since COVID-19 is a novel disease, some patients do not have enough knowledge about the signs and symptoms of COVID-19 and some who are aware of COVID-19 may not be able to differentiate between seasonal flu and COVID-19 due to limited testing facilities in parts of Bangladesh. For these reasons, sometimes COVID-19 patients go to other wards/hospitals which are not assigned for their treatment. This further increases the risk of infection for both the physicians and the patients.

A number of studies have been conducted in different countries on the mental health conditions of different professionals (2, 12–15), but no research on mental health problems of physicians during the COVID-19 outbreak in Bangladesh has been reported so far. Since poor mental health may hinder the professional performance of physicians and adversely affect the quality of healthcare provided, it is also likely to adversely influence patient health outcomes (16). Hence, the purpose of this study was to evaluate physicians' mental health during the COVID-19 outbreak in Bangladesh by quantifying the magnitude of symptoms of anxiety and depression and to explore the potential risk factors associated with these symptoms.

METHODS

Study Design
A cross-sectional study was carried out as the data were collected from 114 physicians through a questionnaire created via Google Form on the internet. We collected the data from May 4, 2020 to May 10, 2020.

Recruitment of Subjects and Eligibility Criteria
Physicians registered by the Bangladesh Medical & Dental Council and working in Bangladesh were considered as potential participants in this study. The participants were selected through convenient sampling technique from the closed Facebook and Messenger groups of the physicians in Bangladesh. All physicians using these closed groups across the country were eligible to participate, and those who completed the survey provided their unique email address in order to reduce the problem of duplicate entries.

Data Collection and Measurements
Physicians participated anonymously in this survey on the Internet and all participants reported their demographic and professional information during COVID-19 outbreak. They also completed two standardized questionnaires which assessed their generalized anxiety disorder (GAD) and 9-item Patient Health Questionnaire (PHQ-9). Participants who had psychiatric disorders prior to COVID-19 were excluded from the platform.

Demographic variables in this study included sex, age, marital status, current residence, living with family, specialization in medical profession, current job location, years of job experience, and work hours per day. Participants were asked whether they were directly engaged in special COVID-19 hospital or unit and those who answered positive were defined as the frontline workers, and those who answered negative were defined as the secondline workers.

We used the Generalized Anxiety Disorder-7 (GAD-7) (17) scale to assess the participant's anxiety symptoms which is valid for Asian region (18). Seven items were evaluated to measure the frequency of anxiety symptoms over the past 4 weeks on a 4-point Likert-scale ranging from 0 (never) to 3 (nearly every day). The total score of GAD-7 ranged from 0 to 21 as the increase of number in scores indicating more severe consequences of anxiety (17). In this study, we defined a GAD total score of 9 points or greater as the presence of anxiety (19).

This study used the 9-item Patient Health Questionnaire (PHQ-9) (20) to assess the severity of depression in this research. This scale is frequently used in Asian research for the measurement of depression (18, 21, 22). The total score of PHQ-9 ranged from 0 to 27. Participants who had a total scores 10 or greater were characterized as having major depression (20).

Ethical Consideration
The study protocol was approved by the Ethical Clearance Committee of Khulna University, Khulna, Bangladesh. Electronic informed consent was obtained from each participant. Participants could withdraw themselves from the survey anytime without providing any justification.

Analysis
Descriptive statistical methods and multivariate logistic regression models were performed to analyze the data. A well-known statistical package, SPSS (Statistical Package for Social Sciences) version 24.0 was utilized to obtain the necessary results.

RESULTS

Demographic and Professional Characteristics
The demographic and professional characteristics of participants are shown in **Table 1**. Of the 114 participants, 76 (66.7%) were men and 38 (33.7%) were women. It was found that age of 86 (75.4%) participants was <35 years and 28 (24.4%) was ≥35 years. Among the participants, 40 (35.1%) were unmarried, 72 (63.2%) were married and 2 (1.8%) were others. Just below half of the participants 55 (48.2%) lived in rented accommodation. Results also show that 32 (28.1%) participants were living alone while majority of the participants 82 (71.9%) were living with their family. Job location of most of the participant's (57%) was Dhaka division while rest of the participants was outside Dhaka division. It was revealed that 67 (58.8%) participants worked ≥8 h

TABLE 1 | Characteristics of the physicians ($N = 114$).

Characteristic	N (%)
Gender	
Male	76 (66.7)
Female	38 (33.3)
Age	
< 35 years	86 (75.4)
≥ 35 years	28 (24.6)
Marital status	
Unmarried	40 (35.1)
Married	72 (63.2)
Divorced/widowed/separated	2 (1.8)
Current residence	
Own house	32 (28.1)
Rent house	55 (48.2)
Residential house/ dormitory	27 (23.7)
Living with family	
Yes	82 (71.9)
No	32 (28.1)
Specialization	
MBSS	74 (64.9)
Medicine specialty	23 (20.2)
Surgical specialty and others	17 (14.9)
Current job location	
Dhaka division	65 (57.0)
Others division	49 (43.0)
Job experience	
<1 year	37 (32.5)
1–5 years	24 (21.1)
≥6 years	53 (46.5)
Working hours per day	
<8 h	47 (41.2)
≥8 h	67 (58.8)
Working position	
Frontline workers	21 (18.4)
Second line workers	93 (81.6)

TABLE 2 | Prevalence of anxiety and depression according to the characteristics.

Characteristic	Anxiety	Depression
	Yes (%)	Yes (%)
Overall	37 (32.5)	39 (34.2)
Gender		
Male	21 (27.6)	20 (26.3)
Female	16 (42.1)	19 (50.0)
Age		
< 35 years	31 (36.0)	34 (39.5)
≥ 35 years	6 (21.4)	5 (17.9)
Marital status		
Married	19 (26.4)	18 (25.0)
Others*	18 (42.9)	21 (50.0)
Current residence		
Own house	8 (25.0)	12 (37.5)
Rent house	19 (34.5)	19 (34.5)
Residential house/dormitory	10 (37.0)	8 (29.6)
Living with family		
Yes	26 (31.7)	46 (46.9)
No	11 (34.4)	24 (29.3)
Specialization		
MBSS	26 (35.1)	25 (33.8)
Medicine specialty	5 (21.7)	9 (39.1)
Surgical specialty and others	6 (35.3)	5 (29.4)
Current job location		
Dhaka division	27 (41.5)	26 (40.0)
Others division	10 (20.4)	13 (26.5)
Job experience		
<1 year	15 (40.5)	12 (32.4)
1–5 years	7 (29.2)	12 (50.0)
≥6 years	15 (28.3)	15 (28.3)
Working hours per day		
<8 h	10 (21.3)	13 (27.7)
≥8 h	27 (40.3)	26 (38.8)
Working position		
Frontline workers	30 (32.3)	4 (19.0)
Second line workers	7 (33.3)	35 (37.6)

*indicates others represent- Unmarried/divorced/widowed/separated.

per day while 47 (41.2%) participants worked <8 h. Among the participants, 21 (18.4%) were frontline workers and 93 (81.6%) were second line workers (see **Table 1**).

Prevalence of Anxiety and Depression During COVID-19

The prevalence of anxiety and depression stratified by demographic and professional characteristics which shown in **Table 2**. The overall prevalence of anxiety and depression were 32.5 and 34.2%, respectively (see **Table 2**).

Potential Risk Factors With Anxiety and Depression During COVID-19 Outbreak

A multivariate logistic regression was used to assess the potential risk factors of anxiety and depression during COVID-19 outbreak and the results of the multivariate logistic regression

model are presented in **Table 3**. It was observed that physicians who worked in Dhaka division (OR = 2.77, 95% CI: 1.18–6.50, $p < 0.05$) were more likely to experience anxiety compared to their counterparts who worked in other divisions. Similarly, physicians who worked ≥8 h per day (OR = 2.50, 95% CI: 1.06–5.86, $p < 0.05$) had more chance to experience anxiety compared to physicians who worked <8 h per day.

Results demonstrate that male physicians (OR = 0.36, 95% CI: 0.15–0.81, $p < 0.05$) were less likely to experience depression that female physicians. Married physicians (OR = 0.33, 95% CI: 0.14–0.75, $p < 0.05$) had less chance of experiencing depression compared to unmarried/divorced/widowed/separated physicians. Physicians aged 35 years or more (OR = 0.33,

TABLE 3 | Results of multivariate logistic regression analyses.

Variables	Anxiety		Depression	
	p-value	OR (95% CI)	*p*-value	OR (95% CI)
Gender				
Female[®]				
Male	0.12	0.53 (0.23–1.18)	0.01*	0.36 (0.15–0.81)
Age				
< 35 years[®]				
≥ 35 years	0.15	0.48 (0.17–1.32)	0.04*	0.33 (0.12–0.96)
Marital status				
Married	0.07	0.47 (0.21–1.02)	0.01*	0.33 (0.14–0.75)
Others[®]				
Current residence				
Own house[®]				
Rent house	0.35	1.58 (0.59–4.19)	0.78	0.88 (0.36–2.18)
Residential house/dormitory	0.32	1.77 (0.58–5.40)	0.53	0.70 (0.23–2.10)
Living with family				
No[®]				
Yes	0.78	0.88 (0.37–2.11)	0.08	0.47 (0.20–1.08)
Specialization				
MBSS[®]				
Medicine specialty	0.23	0.51 (0.17–1.54)	0.64	1.26 (0.48–3.31)
Surgical specialty and others	0.99	1.01 (0.33–3.03)	0.73	0.82 (0.26–2.58)
Current job location				
Dhaka division	0.01*	2.77 (1.18–6.50)	0.14	1.85 (0.83–4.13)
Others division[®]				
Job experience				
<1 year[®]				
1–5 years	0.37	0.60 (0.20–1.81)	0.17	2.08 (0.73–5.99)
≥6 years	0.22	0.58 (0.24–1.41)	0.67	0.82 (0.33–2.05)
Working hours per day				
<8 h[®]				
≥8 h	0.03*	2.50 (1.06–5.86)	0.22	1.66 (0.74–3.71)
Working position				
Frontline workers	0.92	1.05 (0.38–2.87)	0.11	0.39 (0.12–1.25)
Second line workers[®]				

[®]indicates reference category.
*indicates significant at $p < 0.05$.

95% CI: 0.12–0.96, $p < 0.05$) had less chance of experiencing depression than younger physicians.

DISCUSSION

Although the world has experienced several epidemics and pandemics in recent years, such as SARS, MERS, Ebola and influenza A, healthcare professionals seem to be facing increased psychological pressures during the COVID-19 pandemic compared to previous epidemics (23–25). Both anxiety and depression are higher in physicians in Bangladesh during COVID-19 than has been found in previous epidemics (25). Our web-based study showed that the prevalence of anxiety (32.5%) and depression (34.2%) among physicians in Bangladesh during COVID-19 outbreak were high in comparison to previous epidemics, but lower than physicians in China during COVID-19 (18). We have to keep in mind that our data were collected during the early stages of the COVID-19 epidemic in Bangladesh, and at present, no one can predict if or when the epidemic will subside. Therefore, direct comparisons with studies measuring the psychological impact on physicians of previous epidemics may not be directly comparable, since the stage of the epidemic when the study was conducted is likely to impact on psychological distress. Nevertheless, longitudinal research on the psychological impact of previous epidemics found a reduction in depression, anxiety and other psychological disorders 1–3 years post-epidemic, although not reducing to the pre-epidemic

levels (25). This highlights the need for ongoing measurement of psychological distress throughout and post-epidemic, in order to best support physicians now and into the future. If this is undertaken within the healthcare organizations where physicians work (as opposed to only by researchers), then interventions can be implemented quickly and within the practice context of physicians' working days.

According to the results of multivariate logistic regression model, marital status, current job location and working hours per day were found to be significant predictors for anxiety. In addition, gender, age and marital status were highly significant predictors for depression. By considering the magnitude of these selected factors, findings of this study demonstrated that depression were less likely to occur among physicians who were married compared to their counterparts. During the SARS outbreak, a study conducted among hospital employees also found similar relationships (26). A possible explanation of this finding is that married people have been shown to have an overall better levels of mental than counterparts people (27). This difference between married and unmarried/divorced/widowed/separated people may be linked to a sense of stability, social capital, and having a person to share feelings and emotions with after a stressful day working in the hospital. Another study depicted that married individuals had substantially lower risks of death than their unmarried counterparts (28). Hence, marital status should be considered when developing practice-based interventions or attempting to identify "at risk" physicians during COVID-19 pandemic. Results also revealed that anxiety were more common among physicians who worked inside Dhaka division. Since Dhaka division has the largest population and deals with the majority of the COVID-19 cases in Bangladesh (29), this might be contributing factor here. Therefore, physicians from Dhaka division should be provided with specific attention and care from the concerned authority during this or future pandemics.

Our study revealed that workload was associated with the mental health of the participants. Physicians who worked ≥8 h a day had higher likelihood of experiencing anxiety compared to those who worked <8 h a day. This finding suggests that the workload of the physicians needs to be taken into account when considering "at risk" physicians with whom practice-based interventions can be implemented. Whilst this does not deal with the problem of doctors working longer hours, it at least identifies those groups who may be in need of mental health support during COVID-19. In an ideal world with no financial constraints, we would suggest that in order to improve the mental health of physicians during COVID-19, more physicians could be trained/recruited, more physicians could be relocated from rural to urban areas (like Dhaka) and/or task-shifting could be implemented whereby physicians focus on high-risk patients/procedures, leaving lower-risk patients/procedures to other non-medical staff (30). Corresponding to a recent study during COVID-19 (18) and a study during the SARS outbreak (26), findings of our study reported that women were more likely to experience depression compared to men during the pandemic. Previous research has found that females endure more job related stress than men (31, 32), we assume this might be a plausible

explanation of this result. The multiple additional caring roles of women (additional to the stress of being a physician) may add layered stress to female physicians, who may also have COVID-19 related stresses linked to parents, family, and children. That is not to say that male physicians have less of these concerns, but global literature is clear that women take on the majority of caring roles inside the household and family (33).

We also observed that older physicians had lower risk of experiencing depression than younger ones, which is supported by a previous study (29). Our results suggest the need to implement stress management programs (or other interventions aimed at protecting mental health) for younger physicians in order to manage their mental health. Although a study in China showed that during COVID-19, frontline healthcare workers were more likely to experience mental health problems than other healthcare workers (18), we did not find that the working position of the physician had any significant effect on anxiety and depression. Overall, the results of this study indicate that mental health of the physicians require special attention during and after the COVID-19 pandemic, with a specific focus on the particular groups of physicians identified in this research.

LIMITATIONS

When interpreting the findings of this study, some limitations need to be taken into account. The sample size was relatively small and the survey was carried out during seven days of early surge in COVID-19 cases in Bangladesh without any longitudinal follow-ups. We used convenient sampling, hence no sample size calculation formula was used. The sample was self-selecting, which may indicate that physicians who did not take part in our study are different in some way to our participants. The use of closed Facebook and Messenger groups may also have led to a slightly biased sample. As a result, the prevalence of anxiety and depression may be either over or under estimated in the current study. Notwithstanding these potential limitations, we managed to recruit 114 physicians to our study during a time of social distancing (hence the need for online recruitment) and increased workload of physicians, representing the first study of its kind in Bangladesh. Nevertheless, the long-term psychological implications of Bangladeshi physicians are worth consideration for further investigation, in order to build on our results.

CONCLUSION

To the best of our knowledge this is the first study in Bangladesh to assess the prevalence and associated risk factors of anxiety and depression among physicians during COVID-19 outbreak. Findings revealed that the prevalence of anxiety and depression were high among the physicians. Marital status, work per day and current job location were risk factors for anxiety whereas sex, age, and marital status were risk factors for depression. Governments may consider findings of this study for a better health management and an improved health outcome for both physicians and patients.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

ETHICS STATEMENT

This study was approved by the Ethical Clearance Committee of Khulna University, Khulna, Bangladesh. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

All authors contributed equally to the writing of this manuscript.

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A Persons-Centered Approach for Prevention of COVID-19 Disease and Its Impacts in Persons With Disabilities

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The World Health Organization (WHO) considers COVID-19 a great threat to humanity and, thus, declared the COVID-19 outbreak a pandemic on March 11, 2020. To limit its transmission, governments announced lockdowns in their respective nations, and recommended control measures, including behavior change. Persons with disabilities (PwDs) are among the population that may be at a higher risk of becoming infected and may suffer serious illness due to COVID-19. Additionally, lockdowns pose immense challenges and have tremendous impacts on PwDs in terms of receiving their daily support. To mitigate these challenges, their impact, and to reduce the risk of infection, it is important to design strategies that can improve the overall outcome for PwDs. This study therefore intends to provide a uniform strategy or guideline using the person-centered approach principles which is perhaps the most feasible and implementable approach to circumvent the challenges faced by PwDs during emergency lockdowns. Two case studies are used as examples. This pandemic also provides an opportunity for health care planners and policymakers in the health sector to implement reforms to ensure disability inclusiveness in potential future emergency lockdowns.

Keywords: the COVID-19, impact on persons with disabilities, preventive strategies, person-centered analysis/approach, international classification for functioning health and disability

INTRODUCTION

In late December 2019, the deadly novel coronavirus disease (COVID-19) caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) was identified in Wuhan, China (1, 2). Shortly after its identification, the disease spread rapidly across the world, leading to a number of deaths. Since COVID-19 has become a severe global health crisis, the WHO officially declared it a pandemic on March 11, 2020. As of September 29, 2020, the total confirmed cases of COVID-19 have reached more than 33 million, with over a million deaths worldwide (3). The SARS-CoV-2 is transmitted from one person to another, primarily through respiratory droplets or direct contact with contaminated hands or surfaces and then by touching the eyes, nose, and mouth. The first reported transmission however, occurred from wild animals to humans (4). The typical common

symptoms of COVID-19 include a fever, coughing, and shortness of breath. Other reported symptoms, though rare, include a sore throat, fatigue, and muscle pain.

As part of intervention and control measures, governments across the world imposed lockdowns in their respective countries where all transport, including airports, was shut down; and all shops, markets, and schools were closed. Later, a community containment measure with a strict prohibition of movement in hot-spot areas was carried out. Further, additional mitigation strategies were implemented, including behavior change such as wearing of face masks, observing social or physical distance, frequent handwashing and so on. As of September 29, 2020, no medicine for treatment or a vaccine for prevention is available in the world (5).

During the pandemic and emergency circumstances, everyone faces problems or crises, but crises faced by PwDs might be more severe than those faced by any other individual. In such a situation, a set of measures, involving skilled and unskilled manpower, needs to be adopted to ensure care or services to PwDs. There is a need to develop a support system, using universal and inclusive approaches, to care for these special vulnerable groups of people during a lockdown. Researchers across the world have also recommended that there be a disability -inclusive response when addressing the COVID-19 pandemic (6–8).

This current article attempts to present the potential impact of the COVID-19 pandemic and emergency lockdown on PwDs and provides a universal framework or guideline that can readily be considered while planning for care during such a circumstance, irrespective of the different types of disabilities. It applies the principles of the Person Centered Approach (PCA) which requires a group of individuals (Core Groups) for implementation.

DISABILITY AND THE COVID-19 PANDEMIC

PwDs are at a higher risk of being impacted by both the pandemic and the measures being taken to control the pandemic (7, 9). In addition, they may be at a higher risk of becoming infected with SARS-CoV-2 than people without disabilities (10). There are several reasons that may contribute to this higher risk of infection. This could include a lack of adequate knowledge about COVID-19, attributed to the absence of accessible formats of information, frequent need of personal assistance among PwDs leading to increased exposure, inadequate knowledge of preventive strategies like wearing of face masks and handwashing techniques, and poor practices of the disinfection of their assistive devices. For example, a person with a visual impairment relies on touch for daily living activities and mobility, which may increase the chance of infection. Other factors can be attributed to an inaccessible physical environment and infrastructure, and poor accessibility to health care facilities. They are also at risk of negative impacts resulting from the response to the pandemic, due to interruption of daily supplies, closure of out-patient departments of healthcare institutes, and suspension of transportation which impedes caregiver commutes.

In addition, PwDs may have a higher risk of premature death than those without disabilities because of co-morbidities or existing health conditions. In general, PwDs may have poorer health and are vulnerable to secondary medical problems, such as heart problems, diabetes, or respiratory illness (11). For instance, people with a spinal cord injury, may develop urinary tract infection (related to disability), or PwDs may likely develop heart diseases along with complications like diabetes or hypertension, or PwDs may be at risk of contracting flu (12). Furthermore, premature death among PwDs could be due to the absence of a caregiver during the pandemic. In China, a disabled teenager who was left alone died when his relatives and caregivers were in quarantine (13).

PwDs are also more likely to be excluded from schools and have an incomplete education compared to mainstream students. The COVID-19 pandemic followed by the closure of education institutions, will likely further exacerbate the negative impact of education among PwDs. Further, the widespread use of virtual education may not be feasible for students with visual impairments (14). A study reported that a large number of students in Bangladesh are suffering from depression and anxiety due to the pandemic and lockdown (15). Such psycho-social stress may also cause a disproportionate impact among PwDs living both in the community and in institutions like day care centers, in hostel facilities of schools, rehabilitation centers, and vocational training centers. For example, there were reports of panic, stress, and anxiety felt among visually challenged students staying at hostel facilities at schools for the blind, as teachers and other staff were absent due to the sudden lockdown in Delhi (Vision Rehabilitation Staff Dr. Rajendra Prasad Centre for Ophthalmic Sciences, New Delhi, personal communication, October 20, 2020). Evidence also exists that the number of deaths increased from 42 to 57% in care homes in some countries (16, 17).

The pandemic has also led to a massive disruption in the labor market, resulting in a huge economic crisis among many households, including in households with PwDs. An estimate of the impact on global poverty shows that the number of people living in poverty might increase by almost 500 million from the figures reported in 2018. Such strains on economies and livelihoods will, in particular, be much higher in low-and middle-income countries and for PwDs (18). For example, a survey conducted during the pandemic in Bangladesh reported an income drop of 75% in urban areas and 62% in rural areas and many people are facing livelihood uncertainty (19). Further studies on the impact on various types of disabilities, not only health impacts, but also other psychological and psychosocial impacts, and impacts on support systems during the pandemic, are of great importance.

MAGNITUDE OF DISABILITIES

The WHO estimates that more than 1 billion people (15% of the world population) live with some degree of disability, and nearly

FIGURE 1 | The ICF-WHO framework of disability.
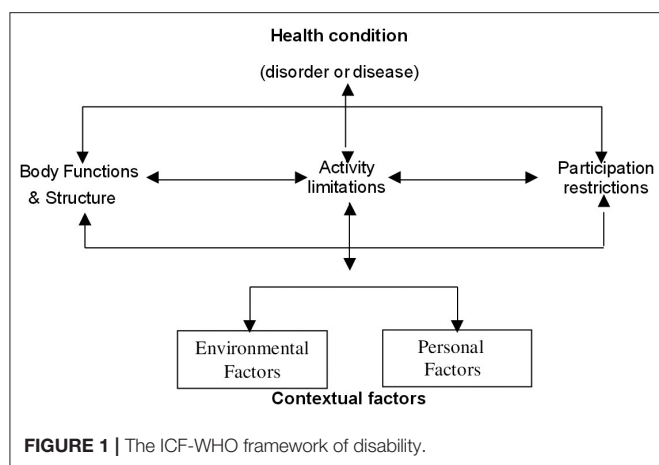
80% of these people come from low middle-income countries, including India (20). For example, the *World Report on Disability* shows that the prevalence of disability is 24.9% in India. Various regional studies in India reported that the prevalence of disability ranges from 2.02 to 64% (21–23). Empirical studies show that the disabled population, particularly from low middle-income countries, have decreased access to health care services, are often isolated, suffer from poor hygiene, sanitation, and malnutrition, are frequently associated with poverty and poor living conditions, and face an increased risk of additional health problems (24, 25). Although this population has the same health care needs as those of people without disabilities, they experience various hindrances or barriers in accessing, and meeting their health care needs.

THE ICF-WHO FRAMEWORK OF DISABILITY

The International Classification of Functioning, Disability, and Health (ICF)-WHO describes disability as dynamic, complex, and multidimensional and defines disability as an umbrella term that covers body impairments, activity limitations, and participation restrictions, resulting in a negative interaction with personal and environmental factors, subsequently leading to disability (**Figure 1**). The primary emphasis of the new ICF-WHO definition is on the environmental and social factors related to the care needs of PwDs. These environmental factors include assistive products and technology, the natural and built environment, and support from and relationships with other people along with attitudes toward PwDs, services, and systems: governments, organizations, laws, regulations, communication, transportation or cultural systems, and policies (20). Personal factors, however, are not part of the health condition; they indicate the particular background of an individual's life and overall behavioral pattern and character. Personal factors also reflect the individual's motivation and self-esteem (26).

PREVENTIVE STRATEGIES AGAINST COVID-19 BASED ON THE ICF-WHO DISABILITY FRAMEWORK

As of September 29, 2020, a total of 235 countries or territories, including India, have been affected by SARS-CoV-2, and more than one-third of the global population are in lockdown as part of a mitigation strategy for COVID-19 (3). In such an emergency crisis, PwDs will have to follow restrictive and protective measures taken up by their respective governments. However, many of these strategies recommended by the government will pose challenges to PwDs, as they may face limitations in practicing the protective guidelines. For example, social distancing may not be possible as PwDs are frequently dependent on others, and disruption of the transportation system, because of the lockdown, may affect caregiver's or personal assistant's movement, leading to serious damage or even death for PwDs (13). In the United Kingdom, people with intellectual disabilities and autism face great difficulty in adjusting to these new environments because of the disruption of their daily support system (27).

Disability is a complex, diverse, and growing global concern. There are many chronic health conditions that can lead to a disability. Every person with a disability has unique features and requirements in their lives. Even individuals with the same disability (impaired vision for example), may have different needs according to their age, gender, experiences, education, and other environmental factors. This shows that there is a need to have an Individual Rehabilitation Plan in place for PwDs. In Person-Centered Approaches (PCA), the first and foremost priority is that healthcare or rehabilitation professionals become acquainted with the needs of PwDs. It is not possible to plan a PCA without being aware of the needs or requirements of PwDs. Therefore, the approach will remain a hypothetical construct until the problems faced by PwDs are established. Once their needs have been established, the PCA can then be applied. A few case studies are included as in this article. The elements described in **Figure 2** of the PCA may not be applied to every client, therefore, the PCA is a universal framework that can provide practical guidance when planning for disability intervention packages.

In a situation like a national emergency lockdown, development of support systems and provision of support from health-care providers to ensure the continuum of care to PwDs are overarchingly important. These unexpected challenges can potentially be managed through innovative approaches that are conceptualized based on the ICF-WHO disability framework, at the same time employing the principles of PCA. The ICF framework provides aspects or elements that should be considered when planning Person-Centered Approaches.

In a PCA (**Figure 2**), the individual with a disability is the active participant; family members, caregivers, volunteers community members to a large extent, and health-care providers are the core groups; and they all work together, thereby making a consensus decision to identify the needs of the disabled individual during the lockdown and to formulate the best possible management plan accordingly, while maintaining the
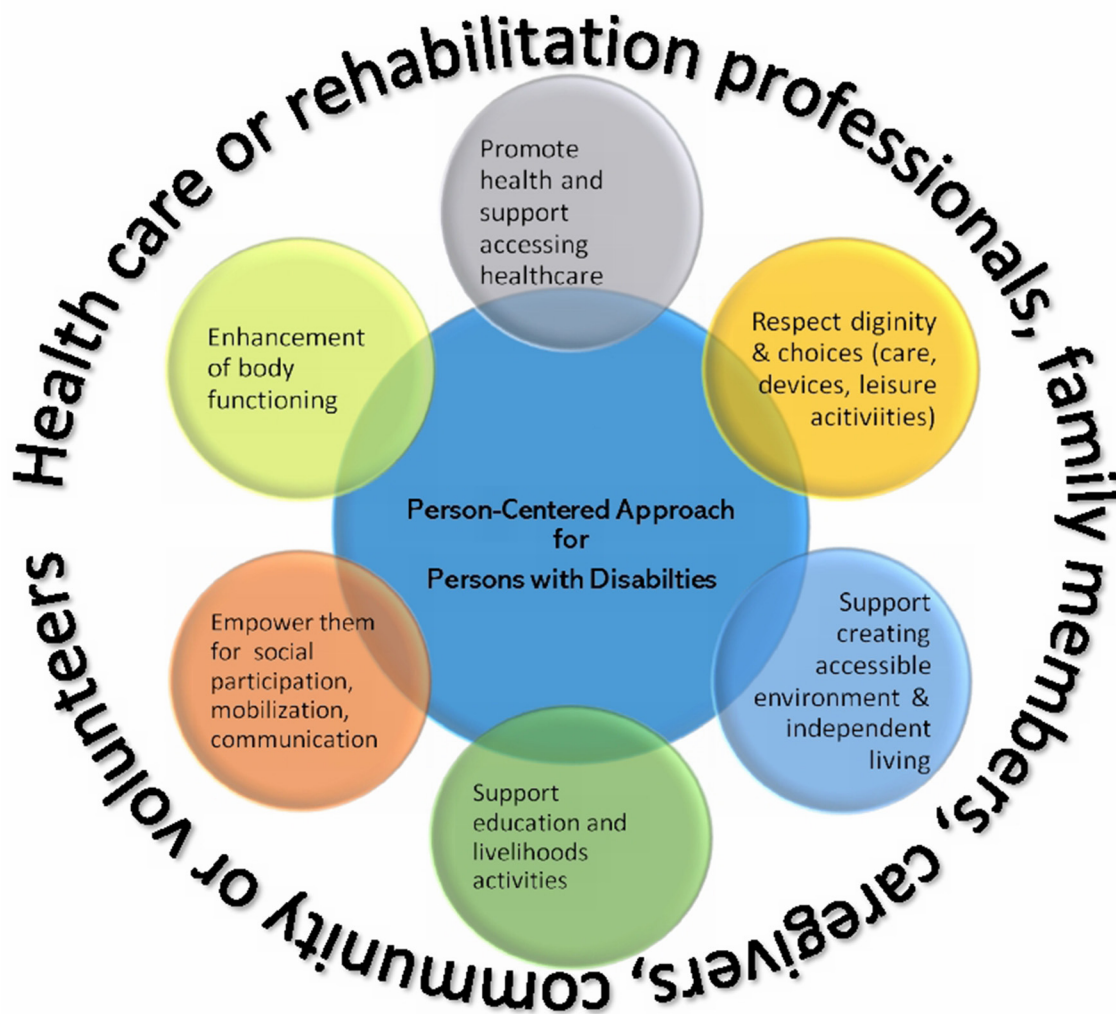
FIGURE 2 | The Person-Centered Approach for people with disabilities.

disabled individual's dignity, values, and respect. Therefore, in the context of an emergency lockdown, a PCA has the potential to reduce the chance of infection or morbidity and to improve the overall impact on PwDs. The focus of the PCA strategy can be planned according to contextual factors (environmental and personal) and participation restrictions of the ICF-WHO framework (**Figure 2**). For example, recommendations based on personal factors may include personal behavior changes like wearing a face mask or frequent handwashing.

Since face-to-face interaction between health-care providers and PwDs or other active core members in PCA is not feasible during lockdown, an alternative strategy to educate PwDs, providing them with all the necessary information, can be done through either telehealth or teleconference methods. Videoconferencing is a preferable technique and would be more effective than other modes of communication. The health care team should take the lead in establishing such facilities. They should contact PwDs as well as the core members identified in the approach, and together devise a plan for inclusive services, which are considered appropriate for the best management of PwDs in

the time of a pandemic. A special communication platform such as a website for care of PwD during the COVID-19 pandemic can be constructed. This website should link to other health care resources, e.g., emergency contact numbers and phone numbers of local service agencies for essential needs. This study suggests the following three key important areas where such mitigating strategies can be considered.

Participation Restrictions

Social distancing is an important measure in preventing infection. In the emergency lockdown, PwDs are encouraged to restrict all outdoor movements, and to stay at home. They can be educated about their higher risk of becoming infected and the possible serious illness that may follow if they contract the virus.

Often, PwDs rely on caretakers or caregivers to perform activities of daily living, e.g., bathing, eating, cooking, or doing laundry. These routine tasks can be managed either with a caregiver or by family members, or even by volunteers from the community who participate in planning for person-centered care. During the lockdown, the government can provide special

permission to allow caregivers (if any) to commute. The best practice, however, is to have the caregiver stay with the PwD during the lockdown period. The government can also consider launching smartphone applications that can connect users (e.g., PwDs) to a random volunteer who registers in the application, either through video or audio calls. For example, the "Be My Eyes" application helps individuals with visual impairments connect with the first available volunteer (sighted) who registers in the application through video calls, thereby assisting the disabled person with any emergency needs (28).

Personal Factors

PwDs need to follow various personal protective measures that are helpful in preventing the transmission of the virus. Despite the many challenges present, PwDs can be motivated to follow the recommended guidelines during the pandemic and to apply self-effort to improve their awareness of COVID-19. They need to adopt various new behavioral changes, such as wearing a face mask and maintaining good personal hygiene and sanitation to the maximum possible level. Education and counseling can also be done to improve their self-esteem while ensuring their dignity and preferences remain intact.

Environmental Factors

Article 25 of the UN Convention on the Rights of Persons with Disabilities reinforces the right of PwDs to achieve the highest possible standard of health and well-being without any form of discrimination based on disabilities (29). Therefore, PwDs' needs should not be ignored during an emergency lockdown. A few recommendations are proposed when responding in the pandemic. First, prepare safe and accessible formats for information on COVID-19, e.g., Braille and sign languages. Second, create an enabling environment for caregivers/peers/community members who can assist disabled persons by providing essential services. Third, provide a supportive environment to meet the daily living requirement within the context of choices made by the disabled person. Fourth, assist in the access for health care services and personal protective equipment. Fifth, improve accessibility of the physical environment. Sixth, promote awareness and sensitization to health-care providers to provide equal opportunities, maintaining dignity and respect whenever a disabled person requires care in hospital. Finally, provide financial support to PwDs during the lockdown period.

Case Studies of PCA During the Pandemic Lockdown

In India, a sizeable number of young persons with disabilities live in accommodation facilities provided by institutions like schools for the blind, vocational training centers, or stand-alone hostels for disabled persons. When the sudden lockdown was announced those staying in these hostel facilities were impacted significantly as teachers and staff were suddenly absent.

Moreover, many visually challenged people who came to Delhi for a new disability certificate or for renewal of the existing certificate, or vocational training, could not find a place to stay nor were they able to return to their home during the sudden emergency lockdown. There are a number of case studies, many

that are unique according to the client's needs, which emerged from our Vision Rehabilitation Clinic (VRC) of Dr. Rajendra Prasad Centre for Ophthalmic Sciences, All India Institute of Medical Sciences, New Delhi that have supported individuals with vision loss through the employment of PCA during the emergency lockdown (30).

Case Study 1

A young visually disabled male aged 18 from Azamgarh, Uttar Pradesh, India came to Delhi on April 15, 2020 to renew his disability certificate. Due to the sudden lockdown, he could not find accommodation nor could he return home. He contacted our team and shared his whereabouts. He was filled with panic and anxiety and explained his problems. He was in immediate need of accommodation. Without delay, our VRC team identified the nearest center providing services to visually disabled persons, and contacted the General Secretary of the center, Gurgaon, Haryana. The center later provided him with free accommodation. The team then further communicated with his family members about the situation. The client was educated about protective measures and provided with the appropriate information about the COVID-19 pandemic to avoid any potential misinformation and misconceptions that can aggravate his fear and anxiety. Psychological counseling was also provided.

Case Study 2

When the lockdown was relaxed in a phase-wise manner, and transportation was re-opened, visually challenged students who were living in the hostel facilities of schools for the blind in Delhi were asked to leave the hostel and returned to their native homes. Once they reached to their respective villages, the local authorities asked them to stay in the village quarantine facilities which was not accessible for PwDs.

A student male who is 100% visually impaired, aged 16 years, and study in the 9th standard at the Institute for the Blind Amar Colony, Lajpat Nagar, Delhi, was asked to leave the school's hostel facilities by the school's authorities. He left the school on June 8, 2020 and reached his native home village located in Dhanbad, Jharkhand, India on June 10, 2020. Upon reaching his village, he was initially denied home isolation. Our rehabilitation team coordinated with his parents and local leaders or authorities and enquired whether the quarantine facility was accessible for the blind. If not, visually challenged students should be allowed to isolate at his own home. Later he was permitted to isolate in his home. Family members and students with disabilities were educated about COVID-19, including the various protective measures. The student in this case study was also educated about precautionary measures he should have taken during the train journey and before he left hostel.

CONCLUSIONS

The current COVID-19 pandemic which was followed with nationwide emergency lockdowns in many countries worldwide, posing immense challenges to the lives of PwDs. A sudden disruption of support systems can have a serious impact on the health of PwDs and may even endanger their lives. These serious impacts can be minimized with an inclusive approach

and planning that is aligned with the principles of PCA, involving PwDs, caregivers, family members, the community to a large extent, and healthcare providers. Once insight and understanding of PCA is gained, planning can move forward according to the needs of PwDs. This article aims to assist healthcare and rehabilitation professionals in constructing an inclusive care plan for PwDs during the pandemic and lockdowns, maybe even during the post-pandemic period. In PCA, PwDs are an active partner, thereafter, the core team can prepare the roadmap. This pandemic also provides an opportunity for health care planners and policymakers in the health sector to implement reforms to ensure disability inclusiveness. The potential impact due to lockdowns can be mitigated if an appropriate planning and policy are in place.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

AUTHOR CONTRIBUTIONS

The author confirms being the sole contributor of this work and has approved it for publication.

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Investigating Preventive Behaviors Toward COVID-19 Among Iranian People

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Background: Considering the importance of preventive behaviors in reducing the transmission of COVID-19, this study was conducted to determine the preventive behaviors toward the spread of COVID-19.

Methods: This cross-sectional study was performed 7 weeks after the confirmation of the first case of Covid-19 by the Ministry of Health and Medical Education in Iran. Data were completed online using a researcher-made questionnaire, the validity and reliability of which were confirmed, for 1,200 Iranians from 8 April 2020 to 9 May 2020.

Results: The mean age of study participants was 37.77 ± 11.20 years. The mean score of preventive behaviors was 62.67 ± 8.53. The results showed that there was a significant relationship between the variables of gender, education, economic status, and preventive behaviors of COVID-19. The highest frequency is related to not using hookah and cigarettes and then avoiding losing and rubbing (78%) and the lowest percentage is related to exercising behavior (16%).

Conclusion: Due to the low level of prevention behaviors during the outbreak of the disease, it is important to design educational and supportive interventions to improve and perform coronavirus prevention behaviors with more focus on men, illiterate people, and poor economic status.

Keywords: COVID-19, health behavior, prevention, education, physical activity

BACKGROUND

Coronaviruses are a large family of RNA viruses that cause disease in humans and animals. These viruses can cause a wide range of respiratory illnesses such as SARS, MERS, and common cold (1). The COVID-19 epidemic is a newly emerging infectious disease virus that was identified in Wuhan China in late 2019 and then spread rapidly across the world (2). Coronavirus is a global threat to public health (3). Currently, due to the lack of effective treatment and vaccines, the best method to deal with this disease is to avoid infection and prevent its spread through protective behavior and personal health (4). Preventive behaviors are behaviors that prevent disease (5).

Behaviors play an important role in providing and promoting health (6). Behavioral changes can be effective in stopping the spread of the disease (7). To stop the spread of infectious disease, prevention guidelines must be followed correctly by individuals (8). Simple precautions are effective in preventing the possibility of infection or the spread of COVID-19:

> Wash your hands regularly with soap and water or disinfect your hands with an alcohol solution
> Observe a distance of at least 1–2 m with other people (social distance)
> Lack of touch of eyes, nose, and mouth Respiratory hygiene during sneezing and coughing.

Stay at home and refrain from attending rallies (9, 10). Many of these behaviors interfere with daily activities, so health advice should be followed voluntarily by individuals and they should adhere to lifestyle changes (8). The results of a study in Greece showed that most of the behaviors that people observed included not contacting people at high risk of the disease and patients with respiratory symptoms. Minimal measures included daily body temperature monitoring, monitoring of cough or shortness of breath, and use of masks in public places (11). Studying individual health-related behaviors and accepting the role of individual behavior in creating and maintaining health is effective in promoting health and preventing disease and evaluating health behaviors (6). Preventing the outbreak of COVID-19 disease is one of the important goals of the health system. It is necessary to study the status of preventive behaviors in developing intervention programs. This study aimed to determine the behaviors preventing the outbreak of COVID-19 to use the results of the study in designing appropriate interventions.

MATERIALS AND METHODS

Study Design and Sample

This is a part of the results of a descriptive cross-sectional study conducted from April 9, 2020 to May 12, 2020 to investigate the behaviors preventing the outbreak of COVID-19 on 1,200 Iranians who have access to social networks (Telegram and WhatsApp) in different cities of Iran. Data were collected online, via a self-reported questionnaire, to calculate the sample size, the formula for estimating the sample size for the mean was used. Ninety-five percentage confidence interval and standard deviation were considered 0.66 according to the 5-choice questions. The accuracy of the estimate was considered 0.04. The minimum required sample was estimated at 1,200 participants. Inclusion criteria included people living in Iran who had access to the questionnaire on social networks and exclusion criteria included people who had a history of hospitalization due to COVID-19. Considering that at the beginning of the questionnaire, the purpose of the study was explained and it was stated that there is no need to write a name and the information will be confidential. After this explanation, those who wished to participate in the study completed the questionnaire.

Measurement Tool and Data Analysis

The self-reported questionnaire was developed by the authors. The questionnaire includes two sections of demographic information (gender, marital status, education, and employment, place of residence, economic status, and history of COVID-19 among friends) and 19 questions related to preventive behaviors of COVID- 19. The output Excel file was transferred to the software SPSS, All questionnaires were evaluated in terms of data quality and outlier data Questionnaires with 10% percent (and more) of uncompleted questions, were excluded from the analysis. Data analysis was performed using SPSS software version 21 based on descriptive and analytical statistical tests t-test and analysis of variance at a significant level <0.05.

Independent Variables

For sociodemographic variables, gender was coded as one for men, and tow for women. Education was categorized into Elementary, middle school, diploma, and university. Work status was broken down into government employee (reference category), non-government employee, retiree, self-employed, and unemployed, Housewives, and health workers. Evaluation from the economic level was divided into 5 categories (very good, good, average, poor, and very poor. In terms of marriage, participants were divided into three categories: single, married and divorced, or a deceased spouse. Also, according to the history of friends being infected with COVID-19 people were divided into three categories (Yes, No. Lack of information).

Dependent Variables

Nineteen questions related to preventive behaviors of COVID-19 with a 5-point criterion based on options (never, Very little, sometimes, most of the time, always). The range of scores of the questionnaire is 19–95. Validity index (CVI) and content validity ratio (CVR) were calculated 1 and the reliability of a questionnaire was 0.89.

Analysis Methods

Data were analyzed based on descriptive and analytical statistics (t-test and one-way analysis of variance) at a significant level of <0.05.

Ethical Approval

All the procedures in this study were approved by the Research Review Board (Research Code: 5329) with the Ethics of committee of Birjand University of Medical Sciences (IR.bums.REC.1399.003).

In order to observe the principles of ethics in research, in addition to the voluntary participation of individuals in the study, the purpose of the research was explained to participants, and questionnaires were collected and analyzed without mentioning the name.

TABLE 1 | Frequency distribution of demographic variables of participants.

Variables		Number	Percent
Gender	Male	362	30.2
	Female	836	69.8
Education	Primary school	15	1.3
	Secondary school	24	2
	Diploma	172	14.4
	Academic	987	82.4
Occupation	Housewife	211	18.5
	Student	134	11.8
	Self-employed	172	8.1
	Worker	23	2
	Employed	420	36.9
	Retired	92	7.3
	Health worker	154	13.5
Marital status	Married	917	76.5
	Single	256	21.4
	Divorced/deceased spouse	25	2.1
History of infection among friends	Yes	196	16.4
	No	889	74.2
	Lack of information	113	9.4
Economic status	Very good	45	3.8
	Good	366	30.6
	Moderate	629	52.5
	Weak	158	13.2
Health condition	Very good	214	17.9
	Good	700	58.4
	Moderate	274	22.9

RESULTS

Social and Demographic Characteristics

The average age of the samples was 37.77 ± 11.20 years, 70.6% females and 76.5% were married. **Table 1** shows demographic characteristics of the participants in detail.

Among the questions that measure people's performance in preventing behaviors from COVID-19, the question related to not using hookah with 83% had the highest frequency and the question related to exercising and physical activity at home with 16% had the lowest frequency (**Table 2**).

Forty-nine percentage of participants wash their hands regularly with soap and water. Seventy-eight percentage of people avoid kissing and shaking hands. 45.53% of people observed social distance. 65.72% of people have used masks in the face of suspicious people or crowded places. 65.97% of people adhere to the principles of social distance and have not traveled.

The mean score of COVID-19 preventive behaviors in the participants was 62.67 ± 8.53. There was a significant relationship between the variable gender, education, economic status and preventive behaviors of COVID-19 (**Table 3**).

DISCUSSION

Considering the role of preventive behaviors in reducing the prevalence of COVID-19, the main way to contain the spread of the virus is to support changes in individuals' behaviors and their compliance with health prescriptions (12). This study was designed and conducted to investigate the preventive behaviors of COVID-19 and its relationship with some demographic variables. The range of achievable scores for preventive behaviors of COVID-19 were (19–95) and the mean score of preventive behaviors is 62.67 ± 8.53. The results of the study showed that the mean score of preventive behaviors in women was higher than men and more than the overall mean score of preventive behaviors in both sexes and there was a statistically significant difference between the mean scores of preventive behaviors in both sexes. In a study conducted by Choi et al., The results showed that preventive behaviors were higher in women, which is consistent with the present study (5). The results of other studies also showed that women performed better in preventive behaviors (13, 14). The highest average score of preventive behaviors is related to people who have a university education level. The results of a study showed that the use of masks has a significant relationship with the level of education (15). In one study, the level of the correct response to preventive behaviors in relation to MERS was 0.22 and Preventive behaviors have a significant relationship with education level (16). In the present study, there is a significant relationship between people's jobs and preventive behaviors. Occupational conditions play an important role in preventive behaviors. The results of the study showed that there is a significant relationship between economic level and preventive behaviors. The average score of preventive behaviors was the lowest in people who assessed their economic situation as weak. Many behaviors, such as wearing masks, gloves, eating healthy foods, disinfecting surfaces, and washing hands regularly, require people to spend money. It is necessary for governments to intervene to improve the economic situation of people with low economic status. Advertising and public health promotion activities supported by government agencies provide cues to increase the use of face masks to prevent respiratory infection (15). In one study, self-report of infection prevention behaviors was not desirable and people especially needed training in the use of personal protective equipment (17). Preventive behavior affected the most significantly by attitude and risk perception (5). Health behaviors are not necessarily interdependent, and individuals can only perform a number of health behaviors. Each behavior pursues a specific goal based on individual experience. It is important that persons recognize that preventive behavior can prevent infectious and could stop its spread (5). In the present study, the frequency of preventive behaviors is different, so that the most behavior is related to not using hookah and smoking and the least behavior is related to regular physical activity at home. In one study, 65.5% of people were able to avoid being in the community (18). In one study, among the flu-preventing behaviors, washing hands with soap and water, covering the mouth and nose when coughing and sneezing were the most common. The use of masks has had the least

TABLE 2 | Frequency of subjects' answers to questions related to preventive behaviors from COVID-19.

Behavior	Never(%) N	Very little (%) N	Sometimes (%) N	Most of the time (%) N	Always (%) N
Wash your hands regularly with soap and water	(2.25) 27	(2) 24	(5.3) 64	(40) 486	(49) 598
Refrain from kissing and shaking hands with others	(4.50) 54	(1.16) 14	(1.5) 18	(14.34) 172	(78) 941
Use your handkerchief or elbow when coughing and sneezing	(0.8) 10	(1.41) 17	(4.17) 50	(24.1) 290	(69.39) 832
Keep a distance of 1-2 meters from others	(0.7) 9	(3.08) 37	(12.92) 155	(37.69) 452	(45.53) 546
Don't go to crowded places and stay at home as much as possible	(1.16) 14	(2.91) 35	(10.17) 122	(38.28) 459	(47.45) 569
Daily disinfection of surfaces at home or at work that come in contact with hands	(1.16) 14	(6) 72	(18.01) 216	(34. 69) 416	(40.11) 481
Dispose of handkerchiefs, gloves and masks used healthy and safely	(1.25) 15	(4.92) 59	(9.92) 119	(27.60) 331	(56.29) 675
Wearing a mask when confronted with a person suspected of having coronavirus disease or being in crowded places	(1) 12	(2.50) 30	(5.50) 66	(25.27) 303	(65.72) 788
Avoid contact with hands, nose, mouth and eyes	(0.75) 9	(3.33) 40	(10.58) 126	(35.86) 430	(49.54) 594
Wear gloves when in contact with contaminated objects and surfaces	(2.41) 29	(6.92) 83	(12.26) 147	(29.44) 353	(48.95) 587
Exercise and physical activity at home	(10) 120	(28.52) 342	(29.85) 358	(15.42) 185	(16.18) 194
Eating healthy foods	(0.58) 7	(2.58) 31	(11.09) 133	(41.53) 498	(44.20) 530
Eat at least 3 servings of fruits and vegetables a day	(3.41) 41	(15.17) 182	(34.69) 416	(25.02) 300	(21.68) 260
Proper ventilation of the home or work environment by intermittent window opening	(1.08) 13	(5.42) 65	(17.59) 211	(34.69) 416	(41.20) 494
Prevent unnecessary attendance at medical centers	(2.83) 34	(3) 36	(5.08) 61	(24.43) 293	(64.63) 775
Disinfect personal items	(0.83) 10	(2.75) 33	(12.59) 151	(31.35) 376	(52.46) 629
No smoking	(11.42) 137	(1.58) 19	(1.16) 14	(3.75) 45	(82.06) 984
No hookah use	(10.42) 125	(1.16) 14	(1.25) 15	(3.58) 43	(83.56) 1,002
Adherence to the principles of social distance and non-travel	(2) 24	(1.83) 22	(4.67) 56	(25.52) 306	(65.97) 791

frequency of behavior (19). The results of another study showed that during the corona epidemic, 97.4% of people tried not to leave the house, 93.6% wore masks when leaving the house, and 91.5% did not go to crowded and closed places (20). In another study, 83.4% of people avoided crowded places and washed their hands regularly, and only 51.2% of people wore masks (21). In a study in Wuhan, China, on preventive behaviors at the time of the outbreak of Quaid 19, 8.5% of those surveyed used public transportation at the time of the outbreak, 2.4% were in crowded places, and 95.2% of They used masks, 100% of people washed their hands regularly with soap and water, and 73.8% disinfected living areas (22). In the study, 40% of respondents most often wore masks in public places and washed their hands regularly (10 times a day), and about one-third of people refused to visit crowded places in China (15). In another study, regular hand washing was moderate, with less than half of people wearing surgical masks (17). In a study in China, 98% of people wore masks when leaving home (14). Regarding their quarantine behavior, only 7% of people were interested in quarantine (23). In one study, the average rate of preventive behaviors in medical students was 47.14 (24). Due to some differences that were observed in the results of the present study with some other studies, it should be noted that the behavior of individuals depends on many factors, including circumstances and situations. Differences in the psychological, cultural, social, and demographic characteristics of the participants, as well as

differences in tools, may be reasons for the discrepancies in the studies.

Study Strengths and Limitations

The results may help health authorities to plan preventive strategies. One of the advantages of the study is that many people from different parts of Iran have entered the study. Due to COVID- 19 disease, this method of data collection was appropriate. One of the limitations of this study is completing the questionnaires only through cyber space. People included in the study who had access to the Internet and social networks. Therefore, in order to generalize to the whole community, it should be interpreted with more caution.

Also, because of the people in cities have more access to social media than villagers, and women use social networks more than men and have more time to complete the questionnaire. Therefore, the majority of study participants were women and urban dwellers. Also data used in the analysis of this study were self-reported, which might suffer from reporting bias.

CONCLUSIONS

Behaviors play an important role in providing and promoting health. To stop the spread of infectious disease, prevention

TABLE 3 | The mean score of preventive behaviors based on demographic variables.

Variables		Mean ± SD	P-Value
Gender	Male	60.21 ± 9.13	<0.001
	Female	63.74 ± 8.03	
Education	Primary School	60.13 ± 12.77	<0.001
	Secondary School	56.59 ± 12.9	
	Diploma	60.43 ± 9.27	
	Academic	63.89 ± 8.00	
Occupation	Housewife	8.55 ± 62.63	0.02
	Student	62.09 ± 9.31	
	Self-employed	8.00 ± 61.08	
	Worker	58.43 ± 7.45	
	Employed	8.55 ± 63.08	
	Retired	64.08 ± 8.06	
	Health worker	63.12 ± 7.53	
Marital status	Married	62.79 ± 8.50	0.02
	Single	61.87 ± 8.69	
	Divorced/deceased spouse	66.60 ± 6.57	
History of infection among friends	Yes	62.60 ± 7.31	0.003
	No	63.02 ± 8.64	
	Lack of information	60.10 ± 9.20	
Economic status	Very good	65.68 ± 7.87	0.001
	Good	64.21 ± 7.83	
	Moderate	8.44 ± 62.36	
	Weak	9.55 ± 59.51	

guidelines must be followed correctly by individuals. The results showed that there was a significant relationship between the variables of gender, education, economic status, and preventive behaviors of COVID- 19. It is important to design educational and supportive interventions to improve the level of physical activity and perform coronavirus prevention behaviors with more focus on men, illiterate people, and poor economic status.

DATA AVAILABILITY STATEMENT

The data analyzed in this study is subject to the following licenses/restrictions: The datasets generated and/or analyzed during the current study are not publicly available due to privacy and confidentiality agreements as well as other restrictions but are available from the corresponding author on reasonable request. Requests to access these datasets should be directed to Mitra Moodi, mitra_m2561@yahoo.com.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by This research is the result of a research project approved by Birjand University of Medical Sciences with number 5,329 and Ethics Code IR.BUMS.REC. 1399.003. Written informed consent from the participants' legal guardian/next of kin was not required to participate in this study in accordance with the national legislation and the institutional requirements.

AUTHOR CONTRIBUTIONS

All authors made substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data, took part in drafting the article or revising it critically for important intellectual content, gave final approval of the version to be published, and agreed to be accountable for all aspects of the work.

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How Australian Health Care Services Adapted to Telehealth During the COVID-19 Pandemic: A Survey of Telehealth Professionals

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Background: In Australia, telehealth services were used as an alternative method of health care delivery during the COVID-19 pandemic. Through a realist analysis of a survey of health professionals, we have sought to identify the underlying mechanisms that have assisted Australian health services adapt to the physical separation between clinicians and patients.

Methods: Using a critical realist ontology and epistemology, we undertook an online survey of health professionals subscribing to the Australian Telehealth Society newsletter. The survey had close- and open-ended questions, constructed to identify contextual changes in the operating environment for telehealth services, and assess the mechanisms which had contributed to these changes. We applied descriptive and McNemar's Chi-square analysis for the close-ended component of the survey, and a reflexive thematic analysis approach for the open-ended questions which were framed within the activity based funding system which had previously limited telehealth services to regional Australia.

Results: Of the 91 respondents most (73%) reported a higher volume of telephone-based care since COVID and an increase in use of video consultations (60% of respondents). Respondents felt that the move to provide care using telehealth services had been a "forced adoption" where clinicians began to use telehealth services (often for the first time) to maintain health care. Respondents noted significant changes in managerial and medical culture which supported the legitimisation of telehealth services as a mode of access to care. The support of leaders and the use personal and organisational networks to facilitate the operation of telehealth service were felt to be particularly valuable. Access to, and reliability of, the technology were considered extremely important for services. Respondents also welcomed the increased availability of more human and financial resources.

Conclusions: During the pandemic, mechanisms that legitimise practise, build confidence, support relationships and supply resources have fostered the use of telehealth. This ongoing interaction between telehealth services, contexts and mechanisms is complex. The adoption of telehealth access to enable physically separated care, may mark a "new context;" or it could be that once the pandemic passes, previous policies and practises will re-assert themselves and curb support for telehealth-enabled care.

Keywords: Australia, telehealth, COVID-19, survey, mechanisms, realist

INTRODUCTION

During the COVID-19 pandemic physical separation between clinicians and patients was encouraged to help reduce the risk of community transmission of the virus (1). To achieve this separation telehealth services were used as an alternative method of health care delivery. This afforded protection to both patients and health care providers (2). A telehealth service is defined by the International Organization for Standardization as "healthcare activity undertaken using information and communications technologies to deliver healthcare and transmit health information over both long and short distances" (3). Telehealth may use synchronous communications technologies such as the telephone or video conferencing or asynchronous technologies such as web-based communications, messaging and monitoring.

Australia had well established telehealth services before the pandemic. Canada, New Zealand and the USA were similarly positioned. National and regional governments in these countries were able to rapidly adjust regulations and payments (4, 5). These changes resulted in a growth in the use of telehealth as demonstrated by, virtual consultations grew from 1,800 each week to 19,000 a week in British Columbia, Canada (6); and in New Zealand telehealth consultations rose ten-fold to 34,500 per week (7), although this figure has since declined.

Substantial increases in the proportion of consumers using telehealth consultations in the USA have been reported (8). American Well, a corporate telehealth service, has stated that 80% of its providers now provide care using telehealth services compared with 20% previously and patient use of telehealth services has increased by a factor of 9 times (9). In France teleconsultations have increased to 11% of all consultations where any application can be used to conduct teleconsultations, including consumer applications such as Skype, WhatsApp, and Facetime. Also in France, tele-monitoring of COVID-19 patients can be performed by nurses and is 100% reimbursable (10).

The introduction of temporary government subsidies radically expanded Australians' access to telehealth under Medicare; and telehealth access to many services was funded by Australian State and Federal governments (11). As a result, there was a substantial increase in the use of telehealth during COVID-19, in particular during stricter lockdowns.

We sought to understand how Australian health services have adapted to the use of telehealth during the pandemic. This research had two broad aims. Firstly, to determine the extent and type of changes that have occurred to telehealth services in Australia since the start of the COVID-19 pandemic, and secondly to probe for explanations as to why these changes occurred.

MATERIALS AND METHODS

The Australian Health Care Context

The Australian health care system is generally regarded as providing high quality, affordable health care services. Australia's health care system and funding models are a complex blend of private and public services. Total Australian health expenditure as a percentage of GDP was 10.3% in 2016 (12). Australia's universal health care system is known as the Medicare Benefits Scheme (MBS). The MBS is funded by a Medicare levy which is 2% levy on taxable income for people earning above a threshold salary. MBS subsidises medical services provided by both General Practitioners (GP) and specialists, as well as a very limited number of allied health services. Many medical practitioners also charge the patient a gap fee which is additional out-of-pocket cost for the patient. Since the commencement of the MBS, the failure to index MBS subsidies has resulted in rising medical fees leaving patients with a larger out-of-pocket gap payment (13).

Primary care services are predominantly provided by privately practising general practitioners (GPs). GP consultations are subsidised using a time and complexity-based fee structure by MBS. In areas where a private model is unsustainable (e.g., remote communities) state health departments or non-government organisations (e.g., the Royal Flying Doctors Service) may provide GP services using salaried doctors.

Acute care services are owned and managed by State and Territory governments with funding coming from State or Territory Governments and the Commonwealth Government. This is often called the public hospital system. Acute hospitals are funded under an activity-based funding (ABF) model. However, hospitals that are not viable under an ABF model are block funded. Public hospitals provide the majority of emergency departments that operate in Australia.

Many Australians also carry private health insurance. Private health insurance predominantly covers private hospital admissions, private dental services and private allied health services. The Australian government provides a 30% rebate on private health insurance premiums to Australians below an earning threshold. Further, the Australian Government has introduced tax penalties for people over 30 years of age who do

not carry health insurance. Despite incentives there is a declining number of Australians with private health insurance. Private health insurance membership for hospital admission has fallen from 50% in 1984 to 47.4% in 2015 and 46.5% in 2017 (14, 15).

Telehealth in Australia

Australia is a large country with intensively settled areas in coastal regions and sparse populations in non-coastal areas. Uneven distribution of the health workforce, particularly specialists, is associated with differential access to health services and facilities for the general population. Regional residents tend to fall into lower income brackets, so the cost of healthcare and travel becomes important. Australian telehealth service models attempt to reduce patient travel to specialist centres by enabling care to be provided into patients' homes or diverting patients to local regional facilities, which then support remote consultations.

In Australia, telehealth services are largely operated by federal and state governments although there is a growing private sector. The federal Government funds telehealth services, under the MBS. States fund teleconsultations within their public hospital systems using ABF. Some states such as Queensland and South Australia run internal video consultation networks which are now gradually opening up to use by primary care practitioners. The Queensland system is by far the largest in terms of usage and has run on an internal network since 2001.

Prior to the COVID-19 pandemic the Australian Federal Government supported a limited range of payments to specialists for video-based consultations as part of the MBS. Between 2012 and 2019 telehealth MBS items were subject to only minor adjustments, but use of these items has steadily increased reaching about 230,000 consultations during the 2018–2019 financial year. State-based public hospitals also provide significant numbers of video-based consultations, for instance Queensland Health provided over 100,000 consultations in 2018. Nevertheless, depending on the speciality, video consultations in both Queensland and Australia as a whole, represented <1% of all consultations prior to the pandemic (16, 17).

Telehealth services grew out of the need to support regional health professionals. Educational use initially dominated (18), but, proportionally, has declined as clinical use has increased. In Australia, telehealth services are almost synonymous with video conferencing consultations (video consultations) between hospital-based specialists and patients in regional areas, at home or supported by local general practitioners or rural clinics. Telephone-based services are focused on providing advice and care directly to patients. Asynchronous telehealth services have been slow to develop or exist under the banner of "eHealth" services, providing diagnostic information between clinicians.

Electronic health records are available across public and private hospitals. In 2018, a survey of Australian general practitioners found that 87% are completely digital and maintain no paper records (19). Telehealth services and eHealth share a dependence on evolving information and communication technologies (ICT). However, eHealth has in the main focused on improving the level of automation and access to information in healthcare, while telehealth services are largely concerned with improving access to care.

Telehealth services rely on communications technologies. In 2007, a new Australian government promised to build the National Broadband Network (NBN) based on an optical fibre telecommunications network. The NBN provides broadband access to 93% of the Australian population, with rural areas obtaining access through fixed wireless and satellite.

Australian Responses to COVID-19 Pandemic

In Australia, the Commonwealth government enabled a wide range of medical professionals to claim rebates using the MBS for consultations that had not previously been eligible for telehealth access. As in-person consultations declined regulations and funding packages were developed to improve the capacity of health services to talk to or see patients remotely using ICT.

Telehealth consultations (telephone and video) formed 28% of all federally funded consultations. Primary care (by GPs), specialist and mental health consultations were the most used. Video conferencing comprised 8% of federally funded telehealth consultations. Specialist consultations made greater use of video conferencing. Mental health consultations, for which video conferencing is an established modality, were provided in almost equal proportions using the telephone and video conferencing (20).

An Australian Bureau of Statistics (ABS) survey (21) reported that "in November (2020), almost one in six (18%) Australians used a telehealth service in the previous four weeks. This was similar to the use of a telehealth in June (20%) and May (17%)." According to the same survey "almost half (49%) reported they were likely to use telehealth services in the future." A separate national study of people's experiences and satisfaction with telehealth during the COVID-19 pandemic in Australia by Isautier et al. (22) found that "telehealth appointments were reported to be comparable to traditional in-person medical appointments by most of our sample (p. 2)."

Study Design and Population

We undertook an online cross-sectional survey of subscribers to the Australian Telehealth Society (ATHS) newsletter between July 5th, 2020 and September 10th, 2020. The Flinders University Social and Behavioural Research Ethics Committee approved this research (Project number 8668). The participant population was chosen according to the recommendation by Manzano (23) because it was likely to reach practitioners of telehealth services who "have specific ideas on what it is within the programme that works (mechanisms) because they are likely to have broad experience of successes and failures, and some awareness of people and places for whom and in which context the programme works" (p. 8). The survey therefore sought to elicit informed views of telehealth practitioners and was not designed to seek the opinions of a broad section of the Australian healthcare community. The survey was administered using a Flinders University Qualtrics software licence that enables respondents to complete the survey online anonymously or via a link contained in an emailed invitation and provides descriptive statistical analysis of the results.

Theoretical Framework

The theoretical approach of this study is founded in a critical realist ontology and epistemology, which views reality as stratified into different levels of activity and observability, and looks for explanations of changes in reality in the form of generative causal mechanisms (24). Recent research into telehealth services has found that continued operation, development, or sustainability of telehealth is contingent on and sustained by interactions between contexts and telehealth services through four key mechanisms, which:

- legitimise practise based on explicit and implicit sociotechnical codes including strategies, guidelines, and clinical routines;
- build confidence through accepting technology, management of the risks, and creation of trust in practise;
- build relationships between stakeholders; and
- acquire resources, such as information and communications technology, human resources, and funding [(25), unpublished doctoral thesis, Flinders University].

Contexts have been identified as crucial to understanding the operation of health services (26, 27). Contexts perform a dual role by hosting mechanisms and changing as a result of interactions with mechanisms. Organisational contexts host the norms, processes, and practises of telehealth services and professional contexts reflect established clinical practises, culture authority, and roles.

Tools and Measurement

The survey has close- and open-ended questions and was constructed to identify changes that had occurred in the contexts within which telehealth services operate, and assess the mechanisms which had contributed to these changes. A total of 40 survey questions were formulated. Because previous work has shown that socio-cultural elements have a far stronger influence on telemedicine adoption and effectiveness than choice of a specific technology solution (27), questions regarding the type of technologies used by telehealth services were not included in this survey.

Questions related to organisational and professional contexts, postulated mechanisms, changes in services, patient experiences and acceptance of telehealth services, sought to understand what constraints on organisational deployment of telehealth services exist. Other questions probed the interaction between professional cultures and the operation of telehealth services? For example:

- Has telehealth been legitimised by clinicians, management and technologists in your organisation?
- How has confidence been built in telehealth services?
- How have professional relationships been maintained?
- What sorts of resources have been important operating telehealth services since the beginning of the pandemic?
- What sorts of changes supported the increased acceptance of telehealth services?
- How has the modality, scope, volume and quality of healthcare delivery using telehealth services changed?
- What changes have there been in the patient experience?

- Have the needs of vulnerable populations been considered?
- Is the provision of remote consultations by your organisation or unit now routine?

The survey was designed to elucidate responses to each research question and encouraged free text comments by respondents on each topic. Respondents were asked to rate the relative importance of proposition or possible factor using five-point sliding Likert items and free text comments.

Data Analysis

For the quantitative (close-ended) component, data were exported from Qualtrics to Excel and then to IBM SPSS for analysis (28). We have applied descriptive and inferential statistics. Proportion and percentages were calculated to describe the main variables of the study. While most data were on a five-point scale (1–5), we have dichotomized the results in to two categories (below and above 3, the neutral) for inferential analysis (29). We applied McNemar's Chi-square analysis, assuming "all categories (expected probabilities) have equal probability" to assess the relationship between selected variables. We have also calculated the Overall Cronbach's Alpha and Maximum Cronbach's Alpha when an item deleted for each item.

For the qualitative component, analysis of respondent comments to each open-ended question was supported by manual methods and NVivo qualitative analysis software (30). Analysis of the free text comments applied a reflexive thematic analysis approach (31) by two independent coders to find repeated meanings. Initially, one coder generated initial themes by identifying interesting features of the data. The second coder used an initial theme set of organisational and professional contexts, legitimisation of practise, building confidence and relationships and acquisition of resources which were aligned with previous findings. The two coders then combined their results and collaborated on their interpretation by iteratively reflecting on and refining themes over a period of several weeks.

RESULTS

Ninety-one ($N = 91$) participants across Australia responded to e-mail ($n = 65$) and anonymous (web link) ($n = 26$) invitations. The majority of the participants were from the Australian states of Victoria ($n = 27$) and Queensland ($n = 25$) and New South Wales ($n = 13$). In total, 54 (59%) participants were directly involved in the provision of telehealth services compared to 34 (37%) participants who were involved indirectly. The role of about one-third participants who were directly involved in the provision of telehealth services was health service manager or researcher. Two-thirds of participants were practising health professionals in general practise, specialist medical, nursing or allied health roles. Of the 29 participants who involved in indirect telehealth services provision, most were technical support ($n = 13$), administrator ($n = 7$) and training or education ($n = 5$) (**Table 1**).

We reported on how healthcare, organisations and professions have adapted to increase the proportion of care provided using telehealth services. We also explored respondent's views on

Characteristics of participants		n (%)[A]
Distribution Channel, n = 91	E-mail	65 (71.4)
	Anonymous	26 (28.6)
Q2.4 Work place, (n = 81)	Australian Capital Territory	2 (2.5)
	Queensland	25 (30.9)
	New South Wales	13 (16)
	Northern Territory	1 (1.2)
	South Australia	4 (4.9)
	Tasmania	1 (1.2)
	Victoria	27 (33.3)
	Western Australia	4 (4.9)
	Outside Australia	4 (4.9)
Q2.1 Level of involvement of telehealth provision, (n = 88)	Directly	54 (59.3)
	Indirectly	34 (37.4)
Q2.2. Role of direct involvement of telehealth provision, (n = 50)	Health service manager, coordinator, or researcher	18 (36)
	Others[B]	32 (64)
Q2.2. Role of direct involvement of telehealth provision, (n = 50)	General practise	4 (8)
	Specialist medical	11 (22)
	Nursing	6 (12)
	Allied health	11 (22)
	Health service manager	15 (30)
	Researcher	3 (6)
	Coordinator	–
Q2.3 Role of indirect involvement of telehealth provision, (n = 29)	Administrator	7 (24.1)
	Equipment supplier	1 (3.4)
	Services provider	3 (10.3)
	Technical support	13 (44.8)
	Training or education	5 (17.2)

[A]The percentage is "Valid percent."
[B]Others' refers to General practise, Specialist Medical, Nursing and Allied Health.

Changes in healthcare delivery	Number of respondents in agreement with statement (n) (%)	Respondents (n)
Higher telephone consultation volumes	27 (72.9)	37
Higher video consultation volumes	21 (60.0)	35
Much better patient satisfaction (telephone) reported	14 (51.9)	27
Much better patient satisfaction (video) reported	13 (54.1)	24
Time spent was about the same as face-to-face consultations	11 (35.5)	31
Main purpose was management or treatment of non-COVID-19 health conditions	19 (55.9)	34
Additional measures had probably or definitely been put in place to support vulnerable patient cohorts	21 (53.8)	39
Extending the type of services offered	30 (52.6)	57
Changing geographical criteria	16 (30.8)	52
Applying different funding or payment criteria	14 (31.8)	44
Some or strong agreement that telephone consultations were routine	28 (82.4)	34
Some or strong agreement video consultations were routine	31 (91.1)	34
No firm opinion existed on whether monitoring of conditions was routine	–	30

the relative importance of legitimisation, confidence building, relationships and resources in enabling these changes.

Changes in Healthcare Delivery

Respondents directly involved in provision of telehealth services were asked to rate their perceptions of changes to healthcare delivery since the start of the pandemic on a five-point Likert item (**Table 2**).

The majority of respondents reported increased consultation volumes. For example, one manager stated "*Our already established tele-rehabilitation program was able to rapidly increase activity from an average 600 service events per month to a peak of 3,300 in April.*"

For other services such as healthcare language interpreters, a complete change in the delivery modality occurred. Interpreter services came to rely on phone and video communications because of the risks of losing staff should they become ill. There was some or strong agreement between respondents that telehealth services were now considered as routine care with one respondent stating "*telehealth (videoconferencing) services is face-to-face services, as we are seeing the patients*

face and they are seeing ours - our patients receive the same care no matter where they are.*" Respondents also noted that the introduction of telehealth consultations had changed the workload for administrative staff because "*while the time taken for consultations is slightly less, the administrative time to arrange appointments has significantly increased, as well as the time required to ensure billing is compliant.*"

Organisational Adaptation

Respondents were asked to comment on factors that they perceived influenced the acceptance of telehealth services. Governmental or organisational decisions (n = 23, N = 52), and the availability of payments (n = 20, N = 48) were cited most frequently as providing a great deal of support. Health reforms or strategies (n = 19, N = 48), inclusion of remote consultations in appointment systems (n = 22, N = 46) and remote consultations becoming part of daily routines (n = 21, N = 52) were felt to have provided a lot of support for the increased acceptance of telehealth services. A respondent noted that "*both clinicians and families have been 'pleasantly surprised' and significantly More buy in now*" while another felt that the changes had not been easy to make, with "*Clinicians forced to adopt - removed some behavioural barriers to uptake and encouraged perseverance until able to competently use telehealth platforms. Noting lot of frustration due to this requirement though!*"

Professional Adaptation

Respondents were asked to compare the extent to which professional managerial, medical or technical cultures assisted the use of telehealth services before and after the outbreak of COVID-19. Application of McNemar's Chi-square test showed that managerial and medical cultures have significantly changed the extent to which they support telehealth (**Table 3**).

Changes to culture were, in the view of several respondents, "enforced" as a result of a risk analysis that compared the risks of infection control during place-based, in-person care with the risks of physically separated care using telehealth services. According to one respondent:

> The external huge risk of COVID made inroads into the status quo - where change was necessary/mandated in order to offer continued care to clients. That is/was the opportunity in a nutshell- the nature of normal risk aversion and standard fear of change got beaten to death by the much larger imposed risk profile.

Another respondent indicated the extent of change in attitudes that had occurred compared to the "*old fears* [which] *have, in many cases been proven to be baseless. It was always the case, but medical opinion is very challenging to impose change on.*"

Legitimisation of Services

Respondents reported that while the legal and contractual arrangements influencing use of telehealth services had not changed during the pandemic, financial constraints had become slightly weaker ($n = 12$, $N = 38$) and collaboration with other organisational units ($n = 28$, $N = 42$), medical specialities or allied health ($n = 29$, $N = 42$) and information technology specialists ($n = 19$, $N = 40$) had all become a little easier. On the one hand the changes to the MBS items were welcomed "*We have been allowed to consult via phone to reduce patients coming into hospital during the COVID 19 time. Previously we were not allowed because this service could not be billed.*"

In Australia, at the beginning of the pandemic patients could arrange telehealth appointments with any GP. Following lobbying by some professional associations who felt that their members were losing business to new entrants to this sector, the government restricted funding for telehealth appointments to patients who had visited the GP practise within the previous 12 months. Consequently, the initial loosening of restrictions to enable all patients to be seen by telehealth, followed by a stipulation that only patients who had attended the same practise within the past 12 months could be seen remotely meant that for one provider:

> For my business, the pull-back of GP telehealth rebates, restricting eligible consultations to a patient's "usual" GP, caused my client base to dwindle overnight. A large proportion of my clients are in vulnerable rural and remote areas, and can't afford health services with no rebates.

Building Confidence in Practise

The survey explored the importance of influences in building confidence in using telehealth services (see **Table 4**).

The confidence of health professionals in telehealth practises was felt to be a key issue because according to one respondent "*clinicians do not want to look silly in front of their patients.*"

Respondents placed particular emphasis on having easy to use systems which are private, secure and well supported by administrative and technical staff. A respondent reported that "*Confidence has grown hugely. Most clinicians are now savvy and adaptable on any platform.*" The ability to choose the most suitable patients to receive care using telehealth services was also thought to be important. A respondent that had been using telehealth services for some time felt that the increased acceptability of telehealth services was not an overnight phenomenon because "*I have worked in reviewing patients via telehealth for over the last 4 years and have slowly watched an increase in acceptability and confidence in the ability to provide healthcare in this manner.*"

Our survey explored how easy has it has been to maintain professional relationships with colleagues at a distance using ICT since the beginning of the COVID-19 pandemic. Respondents reported that while email use had not changed it had become a little easier to use the telephone ($n = 10$, $N = 24$) and much easier to use video conferencing ($n = 22$, $N = 39$) for this purpose. Respondents also reported that achieving consensus with clinicians ($n = 25$, $N = 44$), management ($n = 22$, $N = 43$) and technologists ($n = 21$, $N = 35$) in their organisation on how to implement telehealth services had all become a little easier, with one respondent noting that clinical dominance of telehealth service provision now accommodated greater contributions from other members of the service team "*The team ethos has been reinforced with a much more equal*

TABLE 3 | Changes to workplace culture about telehealth resulting from COVID.

Professional Group	Assisted in the use of telehealth	Most frequent response	Below median, n (%)	Above median, n (%)	McNemar's Chi-square p-value
Managerial culture	Before the outbreak of COVID-19	A moderate amount	17 (51.5)	16 (48.5)	0.001
	After the outbreak of COVID-19	A lot	5 (10.9)	41 (89.1)	
Medical culture	Before the outbreak of COVID-19	A moderate amount	17 (65.4)	9 (34.6)	0.001
	After the outbreak of COVID-19	A lot	5 (12.5)	35 (87.5)	
Technical culture	Before the outbreak of COVID-19	A lot	14 (50)	14 (50)	0.125
	After the outbreak of COVID-19	A lot	7 (20)	28 (80)	

TABLE 4 | Factors associated with clinician confidence in telehealth.

Perceived factors in building confidence	Number of respondents in agreement with statement n (%)	Respondents
It was extremely important to have easy to use systems	37 (67.2)	55
It was extremely important to know systems are private and secure	22 (40.7)	54
It was very important to get technical or administrative support quickly	24 (43.6)	55
It was very important to triaging the most suitable patients	22 (40.7)	54
It was moderately important to trust colleagues	21 (38.8)	54

TABLE 5 | Relationship factors that support the use of telehealth.

Perceived relationships factors that support the use of telehealth	Number of respondents in agreement with statement n (%)	Number of respondents n
Having good leadership was extremely important	28 (59.5)	47
Personal and organisational networks were very important	27 (64.2)	42
Teamwork was very important	24 (60.0)	40
Communities of practise very important	15 (45.5)	33
Formal partnerships were very important	15 (51.7)	29

TABLE 6 | Non-financial resources needed for telehealth.

Importance of resources to operating telehealth	Number of respondents in agreement with statement n (%)	Number of respondents n
Access to suitable technology was extremely important	29 (56.9)	51
Reliable of technology was extremely important	34 (0.68)	50
Staff training was very important	21 (51.2)	41
Access to appropriate physical space was very important	17 (44.7)	38

attitude between team members ie a service philosophy rather than 'clinical is king'."

Supportive Relationships

When respondents were asked about the importance of factors in maintaining relationships that support the use of telehealth services for access to care since the beginning of the COVID-19 pandemic, good leadership, networks and teamwork were mentioned as extremely or very important. Whereas,

communities of practise and formal partnerships were perceived as less important (**Table 5**).

Comments from respondents indicated that while the factors listed in **Table 5** were important, experiences varied. On the question of leadership one respondent felt that "*generally culture has changed around use of telehealth, now being promoted throughout the organization,*" while another complained that "*it has been difficult to get the ear of management as they are occupied with dealing with COVID.*"

Resourcing Services

The non-financial resources which were perceived to be extremely or very important to operating telehealth services are listed in **Table 6**. However, when asked about whether ICT systems in their organisations were able to support telehealth services, respondents were a little hesitant and could only probably confirm that their systems could exchange information ($n = 20$, $N = 41$) and connect with different video conferencing systems ($n = 20$, $N = 40$). Nevertheless, they did believe that these systems were able to maintain patient privacy ($n = 23$, $N = 44$). Access to and reliability of the technology was most frequently considered extremely important.

Respondents welcomed the increased availability of resources, such as "*more personnel available to assist setting up telehealth, more equipment, changes to protocols to make telehealth easier.*" However, some respondents reported difficulty obtaining and supporting services because "*Australia quickly ran out of basic office equipment (webcams, iPads etc became harder to source) Technical support roles were stretched to support across a broader scope and assist with rapid uptake and training.*" Despite these reservations, most respondents indicated that somewhat more technical support for users, devices, communications (such as the internet), and training had been made available to them since the beginning of the COVID-19 pandemic ($n = 15$–20, $N = 28$–35). Respondents were also asked if their organisation uses a National Broadband (NBN) connexion. Of 53 respondents to this question 25 were able to confirm use of the NBN and 15 were unsure. Of those who were sure they used the NBN, 22 respondents indicated the NBN performed satisfactorily, well or extremely well.

DISCUSSION

In this survey 73% of 91 the respondents reported a higher volume of telephone-based consultations compared with 60% of respondents reporting increased uptake of video-based consultations. Telehealth services were used mainly for the management of non-COVID health conditions. Many respondents felt that the move to provide care using telehealth services had been a "forced adoption" where clinicians began to use telehealth services to provide care (often for the first time) and persevered until they felt comfortable with this modality of healthcare delivery. Most respondents identified a learning curve, but perseverance resulted in confidence to use telehealth. Respondents also perceived significant changes in managerial and medical culture, and the legitimisation of telehealth services as a mode of access to care, all of which were important

in the uptake of telehealth. The finding that leadership, and personal and organisation networks were perceived as being more important than formal partnerships and communities of practise is supported by previous Australian studies (32). Access to, and reliability of the technology was considered extremely important. Respondents welcomed the increased availability of resources, more personnel available to assist setting up telehealth, more equipment, and changes to protocols to make telehealth easier. The lower use of video conferencing may be due to a variety of reasons (33), but in part may be explained by variations in need (for instance a video consultation may not be needed when renewing a prescription), and variations in the availability of cameras in consulting rooms or poor interoperability between video conferencing solutions (34).

One of the key contextual changes in Australia has been that the MBS, Australia' universal health system, and associated regulations have both legitimised and resourced the use of telehealth across a much greater range of healthcare activities than were previously allowable. Consequently, there have huge increases in the volume of telephone and video-based consultations between doctors and patients for services funded by the Australian Government via MBS. The new telehealth rebate items in the MBS mirrored the pre-exiting in-person consultation items by adding rebates for telehealth (video) and telephone consultations. In all, 279 COVID-19 items have been introduced (1). In Australia, State governments share the funding of public hospitals with the federal government. State governments provide the resources to the public hospital sector for outpatient and in-patient services, including use of telehealth services. While information on state government funding for this sector is not publicly available, respondents to the survey did report increases in the number of telehealth consultations within the public hospital sector.

Uncertainty about the future of government funding for Australian telehealth services after the pandemic dies down may exist because changes to Australian Government MBS funding rules over the course of the pandemic have proved difficult for some services, with one respondent complaining that "p*re COVID-19 was private billing and then 360 degree pivot to offer patients BB* [bulk billing] *and then 2 months later having to completely pivot again to a private billing only model.*" Other changes made to the original measures have meant that "*clients benefited from four months of Telehealth rebates (courtesy of COVID 19), only to have them wrenched away again*" which raises the question of whether equitable access to healthcare as advocated by the Australian Healthcare and Hospital Association (35) has been maintained during the pandemic.

Changes to the scale of and funding for Australian telehealth services were not the only indicator to change. Managerial, medical (and to a lesser extent technical) cultures were reported to have shifted to support the delivery of care via using telehealth services. Cultural changes have been previously identified as important to the implementation of health service changes in the Consolidated Framework For Implementation Research (CFIR) proposed by Damschroder et al. which "is composed of five major domains: intervention characteristics, outer setting, inner setting, characteristics of the individuals involved, and the process of implementation" (36). Damschroder et al. suggest that the CFIR provides "*a pragmatic organization of constructs upon which theories hypothesizing specific mechanisms of change and interactions can be developed and tested empirically*" (p. 3).

In the inner domain of the CFIR, culture constitutes the norms, values, and charter of an organization. Culture is an indicator of the readiness of an organisation and components of an organisation to undertake the work needed to bring about change (27). Respondents to our survey were of the opinion that organisational changes (in this case the extended coverage of telehealth services), were enforced changes, which were required to maintain the delivery of healthcare when healthcare professionals were physically separated from care recipients. One respondent summed up these changes:

> *Managerial culture is much more supportive. Medical culture is much more supportive. Technical culture has always been supportive but has struggled to embed large volume telehealth services that are acceptable to both patients and staff.*

Our survey also measured other constructs posited within the CFIR, namely the need to build confidence in new practises and maintain supportive relationships. A respondent commenting on confidence in technologies stated that:

> *Increasing confidence with video technologies - not just for telehealth - has led to increasing confidence in and use of technology to collaborate remotely - especially with an urgency to find ways to provide and sustain care for consumers.*

Teamwork, collaboration and networking amongst health professionals were identified as being very important, illustrated by this comment from a manager:

> *our unit runs many meetings each week which have now been transformed to the use telehealth platforms. This has been extremely beneficial to keep things going on a service, education and patient review level. It has also allowed our regional colleagues to feel more like part of the service and partake.*

The CFIR (21) has been referred to in this discussion because it provides a contextually sensitive framework which groups constructs into outer (organisational or societal) settings and inner (professional) contexts. Pawson and Tilley (37) referred to the role of contexts in conditioning "the potential interactions between social or cultural structures and individual or collective agency" (p. 216). The corollary processes, where individual or collective agency expressed through social interactions influence contexts, are the mechanisms which influence social and cultural structures. Mechanisms may be layered and consist of one or more sub-mechanisms which can be considered analogous to the constructs posited by Damschroder et al. in the CFIR (21). Mechanisms operating in the social world "do" work: they can be seen as constructs, processes, or theories explaining "what it is about a program, in this case telehealth services, which makes it work." Westhorp (24) has described mechanisms as processes with multiple inputs which interact with social actors to produce

changes in social (and physical) contexts; that is, they are social interactions which have powers that produce change.

This study aimed to confirm, or otherwise, the influence of high-level social mechanisms that legitimise practise, build confidence in telehealth practises, support relationships between stakeholders, and acquire resources for the use of telehealth services to access healthcare during the COVID-19 pandemic. Analysis of responses to our survey shows that each of these proposed mechanisms have been able, in differing degrees, to "do work" to influence the changes to healthcare delivery resulting in a greatly increased volume and type of telehealth services. These mechanisms were largely triggered by changes in government regulations in response to the pandemic.

In turn, organisational and professional contexts have supported and adapted to the forced separation of care providers and patients during the pandemic. Organisational strategies and revised processes such as inclusion of telehealth consultations in patient appointment systems have supported the use of telehealth services. Professional cultures, especially managerial and clinical attitudes have shifted from hesitant support for remote consultations, to a determined encouragement of this modality. Respondents felt that telehealth services were now considered as routine care, and the Australian Minister of Health has said:

> "We'll work now with all of the medical groups, just this evening I've spoken to the AMA [Australian Medical Association] and the college of GPs [about] using that period over the next six months to complete the process of consultations to make permanent that which we have already created on a temporary basis."(38)

LIMITATIONS AND STRENGTHS

The study has the following limitations. **Table 1** shows that the majority of survey respondents were located in the Australian states of New South Wales, Queensland and Victoria. While these states have high levels of telehealth activity the conclusion we can draw in this paper may not be fully representative of all Australia states. While the number of respondents from these states provides a reasonable sample for the purposes of qualitative research, there remains the potential for bias in our quantitative assessment of the survey due to the limited number of respondents ($N = 91$).

Because participation in the survey was voluntary it is possible that only experienced providers of telehealth services elected to respond to the survey and the views of recent providers may not have been well represented. We did not ask participants if they were employed in public or private healthcare organisations, but it should be noted that funding of telehealth services, which is largely publically derived, whether or not the provider is a private operator. We have not commented on possible variations in adoption of telehealth services by state because the sub-sample sizes are too small to draws representative conclusions.

The survey was designed to ask close- and open-ended questions which sought to identify changes that had occurred in the contexts within which telehealth services operate, and to assess the mechanisms which had contributed to these changes. To our knowledge there has been no validated questionnaire developed specifically for assessing telemedicine adoption. Therefore, the survey questions were not designed to psychometrically measure the attitudes of respondents, which may reduce the validity of sections of our analysis.

In qualitative, research, the sample size required to provide adequate data to support research findings has been related to the point at which additional interviews provide no additional themes when the data is analysed. For mixed method, quantitative and qualitative surveys it is more difficult to define the number of survey responses that provide an adequate amount of data to support the findings (39). We have therefore indicated the number of responses that our discussion of draws on for the reader to make their own judgements as to the adequacy of the sample. While the limited sample sizes for the responses to some questions reduces the power of the conclusions that can be reached, one strengths of this survey is that it is the first survey in Australia to probe the social mechanisms that influence use of telehealth services to access healthcare and therefore lays the basis for further contextual sensitive research in this field.

CONCLUSIONS

Organisational and professional contexts which contain social interactions are themselves not stable but evolve over time under the influence of mechanisms to form new states. Mechanisms that legitimise practise, build confidence in telehealth practises, support relationships between stakeholders, and acquire resources for the operation of telehealth services during the COVID-19 pandemic have been shown to interact with the organisational and professional contexts of Australian healthcare.

Triggered by the pandemic telehealth services have been legitimised to operate on a much larger scale than before and funding in Australia has supported this expansion. As a result of the need to physically distance care, acceptance and confidence in telehealth services as a modality of healthcare delivery has grown significantly. Looking forward to a period beyond the pandemic it is likely that there will be further changes to the regulatory regime for telehealth in Australia. How these changes will affect telehealth services remains to be seen but there have already been calls for health reform which would expand telehealth, encourage outreach and telehealth with new primary care models, better connect the public and private sectors, and expand out-of-hospital care (11).

The ongoing interaction between telehealth services, contexts and mechanisms is complex. The adoption of telehealth access to enable physically separated care, predominately using the telephone, may mark a "new context;" or it could be that once the pandemic passes, previous policies and practises will re-assert themselves and curb support for telehealth-enabled care.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Flinders University Social and Behavioural Research Ethics Committee. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

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COVID/HIV Co-Infection: A Syndemic Perspective on What to Ask and How to Answer

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The present commentary explored the intersecting nature of the COVID-19 and HIV pandemics to identify a shared research agenda using a syndemic approach. The research agenda posits the following questions. Questions around HIV infection, transmission, and diagnosis include: (i) molecular, genetic, clinical, and environmental assessments of COVID-19 in people living with HIV, (ii) alternative options for facility-based HIV testing services such as self- and home-based HIV testing, and (iii) COVID-19 related sexual violence and mental health on HIV transmission and early diagnosis. These and related questions could be assessed using Biopsychosocial and socio-ecological models. Questions around HIV treatment include: (i) the effect of COVID-19 on HIV treatment services, (ii) alternative options for facility-based treatment provision such as community-based antiretroviral therapy groups, and (iii) equitable distribution of treatment and vaccines for COVID-19, if successful. Bickman's logic model and the social determinants of health framework could guide these issues. The impact of stigma, the role of leveraging lessons on sustained intra-behavioral change, the role of medical mistrust and conspiracy beliefs, and the role of digital health on integrated management of HIV care and spectrum of care of COVID-19 need assessment using several frameworks including Goffman's stigma framework, Luhmann's Trust theory, and Gidden's theory of structuration. In conclusion, the potential research agenda of this commentary encompasses a variety of research fields and disciplinary areas—clinicians, laboratory scientists, public health practitioners, health economists, and psychologists—, and suggests several theoretical frameworks to guide examination of complex issues comprehensively.

Keywords: HIV, COVID-19, syndemic approach, framework, HIV care continuum

INTRODUCTION

The human immunodeficiency virus (HIV) (1) and novel coronavirus disease 2019 (COVID-19) (2) pandemics have some similarities. Both diseases are caused by a virus and currently do not have a vaccine or a cure. HIV is primarily transmitted through unsafe sex, blood contact, and mother-to-child transmission, whereas COVID-19 is transmitted through droplets and direct contact. Both conditions may initially present with influenza-like symptoms, such as fever, cough, and difficulty in breathing, although the severity and clinical stage varies (3).

Clinically, patients with COVID-19 have been reported to have one of the following five outcomes (3): asymptomatic (1.2%), mild to moderate symptoms (80.9%), severe (13.8%) and critical conditions (4.7%), and death (2.3%). Some population groups, including people who are older (and male), consume alcohol, have one or more comorbid condition, and live in densely populated settings such as in refugee camps, are at a higher risk of severe COVID-19 related infection or death. Similarly, HIV transmission is high in refugee camps and among people who consume excessive alcohol (4, 5), and AIDS-related mortality is high among older populations and people with one or more comorbidities. Safe sex and use of sterile injection equipment are common prevention methods of HIV transmission. Early case detection, isolation of confirmed cases, quarantine, contact tracing, social distancing, hand washing, and use of alcohol-based sanitizer and personal protective equipment (PPE) are techniques implemented to reduce the risk of COVID-19 transmission.

Given the elements of both COVID-19 and HIV discussed above, a syndemic assessment of the spectrum of both infections may benefit HIV, COVID-19, or COVID-19/HIV co-infected patients. A brief literature review on "HIV" and "COVID-19" has shown some commonalities and interactions between COVID-19 and HIV. These include an increased burden of COVID-19 in people living with HIV (6, 7), increased burden of COVID-19 and HIV in migrant workers (8), increased burden of COVID-19 and HIV in sex workers (9), and increased burden of COVID-19 and HIV in men who have sex with men (10). Mhango et al. indicated COVID-19 lockdowns have impacted facility-based HIV testing and suggest the need to scale up home-based HIV testing in sub-Saharan Africa (11). Additionally, better clinical outcomes of COVID-19 in people living with HIV have been reported (12–15), provoking a debate whether lessons learned from the HIV response can inform effective response to mitigate COVID-19 (16–20). At this stage, we are cognisant the evidence about the interactions, impacts, and synergy between the spectrum of COVID-19 and continuum of HIV care is still building.

The aim of this article is therefore to highlight the potential syndemic perspectives of COVID-19 and HIV pandemics systematically. In particular, it will focus on posing research questions around biomedical, behavioral, psychosocial, and structural issues of COVID/HIV co-infection and potential theoretical frameworks to investigate these questions. This commentary also explores the implications for research in sub-Saharan Africa. Ward has published a research agenda of COVID-19 for sociologists (21) and Holmes et al. on COVID-19 and mental health sciences (22). Our commentary will pose broader research questions, through a syndemic perspective, for clinicians, laboratory technologists, public health practitioners, health economists, psychologists, and sociologists which were not covered in the aforementioned research agendas. Such syndemic framework presents a meaningful and robust paradigm to raise questions on the potential benefits and impact of co-designing COVID/HIV health programming services which can tackle the two pandemics concurrently. While the aim of this article is to ask a myriad of questions and suggest several

frameworks, synthesizing lessons learned from the successes and failures of the HIV pandemic journey is vital. We are aware of evidence demonstrating successful lessons of HIV care to control other non-communicable chronic diseases (23, 24), and we argue there could be a potential research agenda to curb both HIV and COVID-19 based on the cascades of HIV care.

DISCUSSION

Questions Around HIV Infection, Transmission, and Diagnosis

Given COVID-19 facts are new and emerging (only 8 months at the time of writing), the biomedicine of COVID-19, especially about its interaction with HIV, is a new field. The biomedical component of Engel's biopsychosocial model (25) can frame the clinical, analytical, and radiological presentation of COVID-19 in HIV-infected individuals. Specifically, the pathological interaction between the severe acute respiratory syndrome coronavirus-2 (SARS-COV-2) and HIV needs further exploration given its implication for therapeutic and vaccine development. Until this stage of the COVID-19 pandemic, there have been differences in outcomes of COVID-19 patients between people living in Africa (Africans) and people living elsewhere, such as in Europe. For example, the mortality rate in USA, Spain and Italy—the most COVID-19-affected countries in April 2020—were 4.6, 10.5, and 13.1%, respectively, whereas the mortality rates in the most affected African countries in April 2020 were 1.8% in South Africa, 7.2% in Egypt, and 5.3% in Morocco (26). Some explanations about these differences have been related to the differences with high and low exposure to microorganisms and parasites among Africans and Europeans, respectively (27), and the affluence-related travel in Western countries. Debate on these issues has never reached consensus, but the clear differences in the activation, pro-inflammatory, and memory profiles of the immune cells among Africans vs. Europeans require detailed investigation particularly on molecular, genetic, and environmental assessment. The assessment of the role of "trained immunity" and virtual memory T-cells in defending SARS-COV-2, and what this looks like among people living with HIV is also vital. Furthermore, the role of non-biological factors, such as less movement via air traffic and political motivations of countries to "under report" in sub-Saharan Africa, could be an additional research agenda. This will solve why Africa is the least affected continent with COVID-19 so far, given the continent has significant inequities, such as being densely populated, many people living in slum areas, a fragile health care system, a high prevalence of other infectious diseases, low literacy, a highly communal population, a significant proportion of the population living in poverty, and limited access to water (27).

Across the globe, health care services have been interrupted by COVID-19 related measures, such as lockdown or curfew. For example, the interruption of facility-based HIV testing poses a range of questions, including: (i) how does the COVID-19 pandemic affect facility-based HIV testing?, (ii) would the

COVID-19 pandemic necessitate self-HIV testing and/or home-based HIV testing as an alternative option?, (iii) in the context of COVID-19, what would the economic evaluation of self-HIV testing and homebased HIV testing be compared to the facility-based HIV testing?, and (iv) how can COVID-19 related contact tracing be integrated within the self- or home-based HIV testing? These questions could be assessed at individual, community, health institution, and policy levels using the socio-ecological model.

COVID-19 could also increase the risk of HIV transmission as a result of COVID-19 related lockdowns. Already, evidence shows an increase in COVID-19 related sexual violence (28, 29) and poor mental health (30, 31), a point which could be probed using Engel's psychosocial model (25). Furthermore, the consumption of alcohol has been reported to have increased during the lockdown period (32), which in turn could exacerbate violence and subsequently HIV transmission. Hence, the unintentional impact of COVID-19 public health measures on HIV transmission and early diagnosis needs to be explored, including quantifying the number of new people living with HIV as a result of lockdown. While HIV can be transmitted through breastmilk, there is no evidence for transmission of COVID-19. However, as the knowledge about COVID-19 is still emerging, this would be an area for the research agenda.

Questions Around HIV Treatment, Linkage, and Retention

COVID-19 disrupts HIV treatment services, but questions on how it impacts the collection and follow up of antiretroviral therapy (ART) drugs, prevention of mother-to-child transmission (PMTCT) services, monthly ART meetings, and ART training services is yet to be investigated. In many settings, the distribution of HIV promotion, prevention, testing, and treatment logistics have been disrupted because resources to support HIV have been shifted to mitigate the COVID-19 pandemic (33, 34). The impact of these, and related issues, as well as how to address these, need further research. Lockdowns and other public health measures have interrupted facility-based ART care services and further examination is needed if community-based ART groups, "pick and run strategy," and appointment spacing model could be alternative options. Additionally, the economic evaluation of community-based vs. facility-based ART provision, and cost of HIV treatment among people living with HIV or COVID/HIV co-infection need additional investigation. The program theory or logic model conceptualized by Bickman has a number of elements (35) which could guide the exploration of these research questions.

The ongoing ART and combination therapy trials may be the focus of treatment attention. Executing clinical trials and combination therapies could resolve the existing ambiguity between the severity of COVID-19 on immunosuppressed patients (e.g., people living with HIV) vs. the potential effects of HIV antivirals in suppressing SARS-COV-2 replication. Furthermore, the COVID-19 pandemic could also be the opportunity for a research agenda to explore untapped areas, such as the four decades of unsuccessful searching for a HIV cure. Should COVID-19 treatment or vaccine be successful, strategies would also need to be explored to address their cost-effectiveness and equitable distribution. The framework on social determinants of health guides the elements of equitable distribution (36, 37). This will be an essential research agenda, given the lessons learnt from the arrival of anti-tuberculosis therapies in Africa after 35 years (38) and HIV treatment after 10 years (39, 40) of use in the developed west.

Questions Around HIV Treatment Outcomes and Impacts

HIV treatment outcomes among people living with HIV co-infected with chronic diseases, such as tuberculosis, diabetes mellitus, hypertension, and other cardiac diseases, have been described elsewhere (41–49). The negative outcomes across the whole HIV care continuum (50) (i.e., late HIV diagnosis, late presentation to ART care, adherence to and lost-to-follow-up from ART, and clinical, immunological and virological failures) among COVID/HIV co-infected patients and people living with HIV is yet to be comparatively investigated. Such investigation would contribute to the success or failure of the 2030 UNAIDS 95-95-95 treatment targets (51), where 95% of people living with HIV would know their HIV status, 95% of people who know their status would receive treatment, and 95% of people on HIV treatment would have a suppressed viral load. The social determinants of health, such as poverty, gender, low literacy, racial, or sexual minority, immigrants, commercial sex workers, homelessness, and mental health would also need descriptive, inferential, and explorative investigations to find out how they relate with COVID/HIV co-infected patients. The social determinants of health framework by the World Health Organization (WHO) (36) and Baum et al. (37) would provide a guiding framework to comprehensively address these questions.

COVID-19 related stigma is also on the rise (52–54). The health disparity resulting from double, triple, or sometimes quadruple burden and stigma should comprehensively be studied. For example, consistent with other inequities, it would be interesting to explore the COVID/HIV health burden in vulnerable populations, such as poor black migrant women in developed countries. Stigma is a cross-cutting barrier and needs new strategies, including virtual methodologies and other digital health interventions, to halt its multidimensional impact. Goffman's stigma framework (55) and other revised versions (56, 57) could be a starting point of assessment. In relation to this, the quality-adjusted life years (QALYs) and disability-adjusted life years (DALYs) (58) of COVID/HIV co-infected patients need economic evaluation. The WHO quality of life framework (59) would help the exploration of the different components of quality of life, as well as to estimate the QALYs and DALYs.

Questions Around HIV Care Promotion and Prevention Services

Given HIV does not currently have either a vaccine or curative therapy, sustained behavioral change is the main method used to substantially influence positive outcomes of HIV care and treatment. Lessons on the assessment of how

TABLE 1 | Summary of research questions and frameworks to address COVID/HIV co-infection.

Theme	Research agenda	Theoretical framework or model
HIV infection, transmission, and diagnosis	What are the clinical, analytical, and radiological presentations of COVID-19 in HIV-infected individuals?	Biological component of Biopsychosocial model (25)
	What are the molecular, genetic and environmental assessments of African vs. European COVID-19 patients look like?	
	How does COVID-19 pandemic affect the facility-based HIV testing? Any alternative options such as self-HIV testing and homebased HIV testing? And are they cost-effective?	Socio-ecological model
	How can COVID-19 related contact tracing be integrated within the self- or home-based HIV testing?	
	What are the roles of COVID-19 related sexual violence and mental health in HIV transmission	Biopsychosocial model (25)
	What are the unintentional impacts of COVID-19 public health measures on HIV transmission and early diagnosis?	
HIV treatment, linkage, and retention	How does COVID-19 affect the follow up and collection of ART drugs, prevention of mother-to-child transmission (PMTCT) services, monthly ART meetings and ART training services	Bickman's program theory or logic model (35)
	Could community-based ART groups, "pick and run strategy" and appointment spacing model be alternative options in the era of COVID-19? And are they cost-effective?	
	Are there combination therapies to COVID-19 and HIV patients	Biological component of Biopsychosocial model (25)
	Do antivirals have protective effect on COVID-19, or does HIV weaken immunity of COVID-19 patients?	
	What lessons could we learn from the four decades of unsuccessful identification of an HIV cure?	
	How can we address the cost-effectiveness and equitable distribution should COVID-19 treatment or vaccine be successful?	Social determinants of health framework (36, 37)
HIV treatment outcomes, and impacts	What is the impact of COVID-19 on the negative outcomes of HIV care and treatment or the UNAIDS-95-95-95?	UNAIDS 95-95-95 treatment targets (51)
	What does the COVID-19/HIV patient outcomes looks like in terms of social, economic, residence, and gender?	Social determinants of health framework (36, 37)
	What is the impact of stigma of variety origin on outcomes of COVID/HIV co-infected patients?	Goffman's stigma framework (55)
	What does the quality-adjusted life years (QALYs) and disability-adjusted life years (DALYs) of COVID/HIV co-infected patients look like?	WHO quality of life framework (59)
HIV care promotion and prevention services	How can we leverage the lessons on sustained behavioral change at intrapersonal level to achieve improved outcomes of COVID/HIV co-infected patients?	Health belief model (60)
	What is the role of medical mistrust and conspiracy beliefs in the success of public health interventions?	Trust and risk by Luhmann (61), Giddens (62), and Ward (63–65)
	How can we apply the integrated role of peer educators or community health workers for the prevention and promotion of HIV and COVID-19?	Structuration model of collaboration (66), Gidden's theory of structuration (67)
	What will be the role of digital health in the integrated management of HIV care continuum and spectrum of care of COVID-19?	
	How can we leverage learning's from well-implemented COVID-19 mitigation responses to the HIV pandemic?	

ART: antiretroviral therapy; COVID-19: corona virus disease 2019; HIV: human immunodeficiency virus; WHO: World Health Organization; UNAIDS: The Joint United Nations Program on HIV/AIDS.

sustained behavioral change at the intrapersonal level could be achieved [e.g., by health belief model (60)] would need further investigation among HIV/COVID-infected patients. Equally important, the contribution of medical mistrust and conspiracy beliefs, as described by Luhmann (61) and Giddens (62), and more recently by Ward (63–65) can undermine data-driven public health interventions. Beyond the intrapersonal issues, the integrated role of peer educators or community

health workers for the prevention and promotion of HIV and COVID-19 could be vital. Given 80% of people in Africa visit traditional healers, the collaboration of traditional and modern HIV care providers could also be profoundly essential to managing both illnesses. The structuration model of collaboration (66) which has governance, formalization, internalization, and shared goals and vision dimensions, along with Gidden's theory of structuration (67), could be used to guide

the elements of collaboration between the modern and traditional health practitioners.

Vaccine and therapeutic studies for the COVID-19 pandemic have been a research agenda since its declaration, but as yet have not led to successful outcomes. However, as of 30 October 2020, there were more than 2,434 therapeutic and 271 vaccine trials for COVID-19 registered in ClinicalTrials.gov. The fight to realize the rollout of vaccines against COVID-19 and the level of efficacy should be observed continually with the hope of achieving success in the near future. If successful, the cost of the vaccine per dose and the equitable distribution will be an important issue for scrutiny, in particular by drawing on lessons from the arrival of the BCG vaccine in Africa, 50 years after its original use in Europe and USA (68). It is imperative a time-lag does not occur after the implementation of a COVID-19 vaccine in Europe and the USA. Additionally, an agenda should be set to explore the potential implication of the UK's 340 million doses pre-order of four different vaccine types for COVID-19 (69), USA's 100 million COVID-19 vaccine doses pre-order (and agreement to procure an additional 500 million doses) from two vaccine companies, and charging extra health insurance for Americans even if it is said that "*the COVID-19 vaccine will be made available to Americans at no cost*" (70).

Cross-Cutting Questions Around HIV and COVID-19 Care Services

The role of digital health in the integrated management of the HIV care continuum and spectrum of care of COVID-19 needs special attention, given the current and ongoing use of technology in health-related services. The application of technology on data collection for COVID-19 related research, potential biases and how to address them; the expansion and innovation of mobile applications for contact tracing (71) in Singapore, South Korea, Australia, and other countries; and the use of social media for research findings dissemination are some additional avenues for research.

The COVID-19 pandemic has so far caused unprecedented health, economic, and social impacts globally, with Europe and USA being the most affected regions, while other locations have responded well, such as South Korea who even conducted an election successfully during the first wave of the pandemic (72). Even within countries there is strong evidence of differing pandemic responses and the impact this has on risk mitigation. For example, in Australia the community-driven response by Aboriginal Community Controlled Health Organizations was initiated in a timely, clear and culturally appropriate way resulting in a highly successful response for Aboriginal and Torres Strait Islander Peoples (73, 74). This community-led leadership, which occurred separate to government-driven leadership and messaging, has resulted in very low levels of COVID-19 among this at-risk population (75). Such

disparities in COVID-19 pandemic outcomes between regions and communities pose questions about the impact of leadership on COVID-19 and crisis management, and the performance of countries to mitigate the pandemic and its complications in general. The performance of low- and middle-income countries who performed well in mitigating the COVID-19 pandemic i.e., they are "punching above weight," and developed countries who performed less well i.e., "punching below weight" needs further investigation. Baum et al. (37) proposed a framework on how to compare punching above and below weight countries (37).

Table 1 presents the summary of research agenda and respective theoretical frameworks.

CONCLUSIONS

This commentary identifies a number of research questions for multidisciplinary specialists. The research agenda includes questions around transmission, diagnosis, treatment, prevention, and control of the HIV/COVID-19 syndemic. We have suggested several theoretical frameworks and models to guide examination of complex issues comprehensively. The outcomes of such research will hopefully provide evidence on how to effectively manage people living with HIV, diagnosed with COVID-19, or co-infected with COVID/HIV in terms of improving the prevention, promotion, and diagnosis alongside better linkage to, compliance with, and outcomes from treatment and care. We urge researchers and research funding agencies to collaborate with each other and people with lived experience to ensure these research agendas are addressed, and to further generate new questions to be identified over time. Research studies need to answer the proposed questions within a variety of contexts, including income (low-, middle-, and high-income countries), population (children, adult, older age and most-at-risk population), culture, education, and other variables. Our HIV/COVID-19 syndemic research agenda complements other recently published COVID-19 research agendas, and together we hope more integrated and complex research can eventuate. Although this commentary suggests numerous research questions, along with known theories and frameworks, we acknowledge these may not be feasible in practice—the so-called "self-fulfillment prophecy" —due to resource limitations. Despite this, we believe our proposed research agenda provides a guide for researchers and research funders to explore new and innovative areas to address both pandemics.

AUTHOR CONTRIBUTIONS

HG, LM, JS, KW, and PW conceived the idea. HG drafted the manuscript. All authors critically reviewed and approved the final version of the manuscript.

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Women Face to Fear and Safety Devices During the COVID-19 Pandemic in Italy: Impact of Physical Distancing on Individual Responsibility, Intimate, and Social Relationship

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The COVID-19 pandemic of 2020 in Italy had its first epidemic manifestations on January 31, 2020. The socio-sanitary rules imposed by the government concerned the social distance and management of intimate relationships, the sense of individual responsibility toward public health. Physical distancing and housing isolation have produced new representations of intrafamily, generational, neighborhood, community responsibility, bringing out a new "medicalized dimension" of society. In light of this contextual framework, the research aims are to analyze how: the perception of individual responsibility for public and familial health and physical distancing has redrawn the relation between subjects-family-community; the State's technical-health intervention has reformulated the idea of social closeness, but also how the pandemic fear and social confinement has re-evaluated a desire for community, neighborhood, proximity; during the lockdown families, friends, neighbors have reconstructed feelings of closeness and forms of belonging. The methodology used is quanti-qualitative and involved 300 women through an online questionnaire. The data collected highlight how the house during the lockdown is perceived as a safe place and how women implement both the recommendations and the behaviors aimed at preventing contagion, but also ways that allow coping with the situation from a perspective of well-being. Furthermore, the data show how the dimension of distancing has loosened the relational dimension outside the family unit, with a greater distancing compared to pre-pandemic data. However, the majority of women report that they have joined solidarity initiatives, demonstrating that they want to maintain ties and participate actively in community life.

Keywords: COVID-19, physical distancing, social responsibility, health citizenship, Italy

INTRODUCTION

The world emergency that emerged with the COVID-19 contagion has brought out numerous reflections on these aspects, in particular with respect to the relationship between security, care for the weakest and intergenerational relations that are realized starting from the idea of a sort of "health citizenship" (1) where access to resources is granted to those who fall into behavioral

patterns of protection against risk. Despite the differences in the different countries, in many cases the institutional health policies have rewritten the intergenerational pact promoting care through physical distancing. Distancing care is a well-known issue in transnational families (2–4), where literature has long reflected on the implications relating to the difficulty of reconciling care and physical distance; a theme that up to now has concerned migrants, while it was totally unknown to families living close by. Among the most effective slogans of the social persuasion campaign to adopt socio-sanitary norms were: "Distant but united." Physical distancing and housing isolation have produced new representations of intrafamily, generational, neighborhood, community responsibility, bringing out a new "mediatised dimension" of society.

The pandemic emergency has radicalized the trends already in place in society and produced new and unexpected reconstructions of the social bond, and of the public dimension of individual responsibility. In the pre-COVID society, studies had highlighted the growth of the individualization process, both in the family (5–7), and in society (5, 8, 9).

Social and health policies to combat COVID-19 on the one hand imposed the need for physical distancing and isolation, while on the other, it brought to light the "removal" of the community, of solidarity, from family and relatives to that of the neighborhood, and even on a national level. The confinement has caused many psychological strain that has leaded, for example, to alters physical activity and eating behaviors in a health compromising (10). In many cases, these effects have been mitigated through the use of technology that has allowed the opportunity for social relations to be maintained (11). During COVID-19, there have been many episodes of reconstruction of micro neighborhood relationships (support for the elderly in shopping, exchange of conversations between neighbors from balconies, community singing), of building familiar and friendly communities through web devices.

The fall of the myth of the omnipotence of biomedicine has paved the way toward the perspective of considering medicine as a collective phenomenon and therefore of common interest (12, 13). The knowledge of biomedicine centered on technology and technique has been overwhelmed by a shock of reality and has given way to simple rules of common sense: wear a mask, clean and disinfect your hands frequently, avoid close contact, keep a physical distance of at least 1 m, sneeze or cough into the crook of your elbow. Public health policies to combat the pandemic have wagered on people's adherence to the rules of containment and social distancing: a meter has become the measure of our sociality. Clear rules of common sense which, as Beneduce (14) observes, derive from a "common-trivial, intuitive or feminine knowledge." The reference to the world of women with respect to self-care and others, takes up the focus of our article aimed at investigating the role of women and women's actions in response to health as a "collective good of common interest." Indeed, research carried out on eight countries, including Italy, showing how woman are more careful to spread and take steps in adopting behavior imposed by the state to protect herself and others, and so to adopt more altruistic approaches (15). According to Cheng, Lam and Leung (16) awareness of governments and

the WHO on the massive use of masks has shifted attention from protecting oneself to protecting others, taking the form of altruism and solidarity.

The measures adopted, such as containment, distancing, and personal protection, in the early period of the pandemic were not accompanied by policies of tests and targeted isolation or tracing the contagion, meaning that people were confronted with the burden of responsibility for the success of public health policies. A situation well-condensed in the expression "we are healthcare," circulated during the most dramatic moments of the pandemic. This responsibility is configured in its double dimension, ethical-moral and juridical. In fact, scrupulously adopting the provisions indicated by the Government becomes indicative of being a virtuous citizen, worthy of health citizenship. Following the rules testifies to fidelity to the "collective pact" to save public health (17), but at the same time it is also a duty, because non-observance of the rules is punished with sanctions. Therefore, adhering to the "collective pact" means acting responsibly for the protection of collective health. The speech by Italian Premier Giuseppe Conte in the press conference in which he announces the lock-down is a sort of founding act of the "collective pact," the only tool to deal with a "new" virus of which "there is no great scientific evidence" and therefore there are no known medical cures for healing. In the words of the Premier, adherence to the "collective agreement" calls for a direct, emotional, sentimental involvement of people called to safeguard public health through responsible action aimed first of all at their most fragile loved ones (parents, grandparents). In this message, the idea appears that citizens exposed to risk must be protected by the same community, organized in concentric circles of proximity, where the one closest to the subject coincides with the group of loved ones (partners, children, family members) then that of friends, neighbors and gradually on toward the national grouping. Furthermore, the feeling of participation in a larger, national community is strengthened as it drags with it the sense of fidelity to a pact built in the sphere of the most intimate affections. Clearly, this is an "unexpected" idea of community, musicalized through a social new order based on "staying at home" and on social distancing.

VARIABLE GEOMETRY QUARANTINE: PUBLIC HEALTH POLITICS AND REGULATORY DEVICE IN ITALY

On 29 January 2020, a couple of Chinese tourists were rescued from a hotel in Rome by an ambulance with nurses dressed strangely in protective suits and white overalls. The whole of Italy was dismayed by such unusual and apparently out of place images. On 30th January, the Italian government proclaimed a state of emergency with consequent measures aimed at containing the infection throughout the national territory. Attitudes, body postures, lifestyles that have always been considered natural enter a shadow. The contagion of the virus feeds on social proximity. Kissing, hugging, greeting each other with a handshake, relaxing with friends, having a dynamic life are stigmatized as behavior in conflict with

the protection of public health. Italy thus entered a path of progressive regulatory restriction of everyday behaviors that up until then had regulated social life, even in the most intimate aspects of the manifestation of affectivity and sociality. The Decree of the President of the Council of Ministers (DPCM) shows that medicine and political power "continue to intersect" and exercise a power that penetrates "invisibly into bodies, into behavior, shaping our experience" (14, 18). On the other hand, local adaptations, generally in a more restrictive sense than government measures aimed at social containment and distancing, show the centrality of "principle of responsibility" as a "principle of political action" (19).

We are interested to emphasize the function of the DPCM and institutional communication to support the rules against COVID-19, in identifying scales and methods of responsible action. The house, the perimeter around the house, the neighborhood, the places of basic necessity (supermarkets, pharmacies), the country in which you live constitute the boundaries of a progressive cartography within which to circumscribe social action at the time of the COVID-19. Sociality protected by masks and physical distancing constitutes the form within which to continue a safe social life for oneself and for others. The containment and distancing measures have a progressive trend that heads down from the international context and toward the domestic. Within a few weeks, the first outbreaks broke out in two regions, Lombardy and Veneto. The DPCMs, which then followed on constantly until early March, progressively extend the "red zones" from the North to the rest of Italy and follow the degree of alert of the pandemic globally. On 4th March, schools and universities closed all over Italy. Until 11th March when, in conjunction with the WHO declaration of a state of "global pandemic," Premier Giuseppe Conte announced with a live TV broadcast and Facebook post that he had signed the DPCM whereby the "red zone" was extended to include the whole of national territory. Italy came to a standstill. The home and the co-residence family community represents a safe place from various points of view from aspects of sociality and psycho-physical well-being, economic, emotional and affective one to the hygienic and food safety point of view (20). So, family becomes a safe place capable of controlling and preventing contagion. However, according to literature, family relationship inside home can be a protective factor or a condition of fragility within which the health of its members develops (21, 22). Moreover, because the family is system characterized by interdependent relationships (22, 23) the well-being or the malaise of one of its members affects other individuals. The family environment has a relevant not only for psychological health and quality of life, but also for individual adaptation and well-being of different members (24, 25). In actual fact, the forced coexistence during the lock-down period has also highlighted extreme situations of conflict, sometimes resulting in violence against women or children (26, 27). Furthermore, the communication campaigns that preceded and reinforced the regulatory provisions of the lock-down were based on direct and to-the-point slogans, among the most used: "I'm staying at home," that refers to a sense of responsibility and self-discipline. Progressively, the "boundaries of everyone's world have narrowed more and more, until they coincide with the walls of our homes" [(28), p. 76].

FROM FAMILY COMMUNITY TO HEALTH CITIZENSHIP

In contemporary society, a feeling of nostalgia prevails, which accompanies the loss of the community of the past, idealized as place where relationships were immediate and supportive (29–31). Clearly, this is an idealization, since the communities of the past had many contradictions and paradoxes, the first being that of the relationship between safety and freedom (30). This contradiction is among the first factors to ensure that the communities of the past cannot return. Nonetheless, the idea of community in recent years has made its way unexpectedly, so much so that it is not immediately recognized. One of the characteristics of contemporary communities is that they are not tied to a territory, they are nourished not so much by face-to-face relationships but by "virtual neighborhoods" or transnational landscapes (32). The Social Street, for example, is a group of fellow citizens who meet for the achievement of a common advantage, it was born on the web, uniting people who do not know each other but who live on the same street. A recent research highlights how women, which belong to the Social Street, can become promoters of psychological well-being and healthy communities (33). Other examples are patrimonial communities, among all patrimonial food communities, or the communities constitutes for the protection of "common goods." How this trend has been further increased, however modified, under the push of medicalization of the social, of physical distancing, of the sense of fear toward the closest people considered as potential carriers of contagion.

Palumbo (34) considers the pandemic a "hybrid" and its effects include that "of staging a return of the social," in the "re or hyper-mediatized" form. The re-emergence of the social crosses the theme of the community in the sign of hybrid and paradox. Migliorati (28) focuses on two types of communities that advance: one that, on the proposal of singing, playing, speaking from balconies, refers to the recovery of an "old ancient world" [(28), p. 73], destined for the most part to fail as prophesied by Bauman (30). In fact, these proposals have mainly had a media life on social networks and have mostly constituted an attempt to represent a national community made up of neighborhoods that adhered to the government slogan "everything will be fine." Migliorati (28) reports a funny voice message on WhatsApp circulated during the lock-down period that says: "I have been locked up at home with my family since yesterday; they seem like good people" [(28), p. 72]. Clearly, this is a joke, which shows how often, in fact, our hectic lives do not allow us to devote sufficient time to cultivating family relationships. Therefore, if, on the one hand, the nostalgic recovery of forms of sociality based on a community model of the past is destined to fail, the imposition of staying at home has forced everyone to stop and devote more time to the family (28). But, as Smith et al. (35) emphasize, COVID-19 highlights the Connectivity Paradox of staying connected but distancing which

leads "distanced connectivity." Family communities are thus segmented internally, separating those who are in good health from those who are medically fragile. This division separates the generations and invites the younger to be responsible toward the older ones. A responsibility that paradoxically manifests itself through physical but not emotional distancing. The distancing from loved ones is presented as a necessary sacrifice, an act of love. One of the slogans of the institutional communication campaign is "keeping grandparents away to embrace them later."

A final interesting aspect concerns the way in which health policies cross the theme of the community in the dimension of health citizenship. It presents itself as a form of belonging that redesigns the relationship between individuals and the State and has changed the sphere of personal rights. Health citizenship is increasingly present in the public and scientific debate in relation to disease prevention and health management in the context of profound demographic, ecological, economic, and political change (36). The relationship between health citizenship, rights and responsibilities changes over time and determines different configurations of public health systems and practices. In particular, the social meaning of health citizenship changes in relation to the role of public health in the construction of states, the theories on the healthy body and the role of biological determinism in the construction of subjective identity and the rights to health (36). Citizens who actively participate in the "collective pact" for the rescue of public health enter the sphere of health citizenship, as we have already specified in the previous paragraph. Otherwise, those who do not adhere to the new public security order are marginalized or stigmatized (37). One example is the public debate of stigmatizing the behavior of university students from the southern regions who study in northern Italy. On 8th March, Premier Conte announced the ban on moving the areas of northern Italy included in the red zone. A few hours before the official publication of the DPCM, the news spreads on social media. Many students and workers originally from southern Italy residing in the north, "attacked" the trains to return to southern Italy and their families. The public debate, the newspapers stigmatized those who returned from the north seen as a "smearers" and models of "bad" citizens. The south region governor of Apulia declared: "you are bringing us many other outbreaks of contagion that we could have avoided. (…) I remind you (…) that you must stay away from parents, siblings, grandchildren, friends, grandparents and sick people who risk dying if infected." Indeed, responsible action is constituted as an act of citizenship (38) that expands the rights of health citizenship beyond the established limits toward levels of greater inclusion.

A GENDER PERSPECTIVE: WOMEN AND THE COVID-19 PANDEMIC

In literature, when we relate to gender, we refer to roles, responsibilities, and power relationships that are socially constructed and assigned to men and women in a given society or community. Gender perceptions are deeply rooted, vary widely within and between cultures and change over time, however in all cultures, gender determines power and resources for women and

men (39–42). As Bond et al. (43) state, the focus on gender role development can be considered one of the most important areas of community development. In agreement with Rollero et al. (44) paying attention to gender equity affects many indicators of community life including the well-being of the community itself, making it more competent and capable of creating human and social capital. The attention to the development and well-being of the community in its sociological and psychological components is based on a situated analysis of human behavior and is particularly suitable for the analysis of gender as a context, in an inter-sectional perspective, in which the spaces of intersection of power relations are evaluated (45). In addition, focusing on the community gender dimension makes it possible to understand what is happening and to promote and produce social change. Just as Lewin's teaching on changing eating habits started from the guardians of food, so too, in this pandemic situation, understanding how women act and what they do to protect health can become an element for implementing social changes that "do not arise within an empty space but are part of the daily rhythm that pulsates between alternating sleep and wakefulness; of solitary and group life; of play and productive work; of belonging to a city, a family, a social class, a religious group, or a nation" [(46), p. 30]. According to Levine and Perkins (47), every sustainable social organization has structures and meanings that ensure its continuity in spite of environmental vicissitudes. Although much research shows that women suffer greater malaise and are more fragile in relation to this pandemic situation (48, 49) however, there is a lack of work from a gender perspective showing the condition of women in relation to the experience of distance and how this condition has brought about changes in family and community relations and has seen women themselves as active protagonists of solidarity actions and individual vs. collective responsibility. In order to ask for more attention and reflection and promote policy interventions for health and to consider the contribution of women to the health of the community (50). Moreover, the importance of attention to the involvement of people in their own health choices is now known (51, 52) and how the changes introduced by new health technologies make the relationship with health more predictable, which in this pandemic situation, on the other hand, seems to waver but, at the same time, require the person to internalize the idea of inevitable risk (53, 54), which in this context becomes even more pervasive.

AIMS

Based on this theoretical framework, and pandemic socio-political condition, we intend to investigate in a gender intersectional perspective the impact of physical distancing, within family and community relationships during the end of first quarantine period that the Italian population found itself facing (April–June). The focus on the role of women in respecting and promoting the rules of containment and social distancing, and how the perception of female individual responsibility for public and familial health and physical distancing redraws the relation between subjects-family-community and how the

vision of health as a collective good to be protected extends health citizenship and has changed the sphere of personal rights. Moreover, in light of these changes, considering to family relationship and family conflict are other significant dimensions to investigate.

PARTICIPANTS

The sample numbered 300 Italian women, distributed throughout the national territory, with an average age of 41.40 years (SD = 15.51, range 18–83). Regarding marital status, half of women (50.3%) declare that they are married/cohabiting, while 39.6% are single, 8.7 % are separated/divorced and 1.3% are widows. Considering the people with whom women live during the COVID-19 emergency, 14.1% say they are alone, while 23.9% live with another person, 30.6% with two other people, 23.6% with three other people while 7.7% live with more than four people. Moreover, women living with one or more people, in 63.3% of cases live with their families, in just 22% with a partner and 4.7% with friends or housemates.

Most of the women have a university degree (41.1%) or post-graduate qualification (19.7%), while 36.1% have a secondary school diploma and 3.1% have finished middle school. Regarding the family income the participant declares in 16% of cases up to € 15,000, in 37.1% of cases between 15,001 and 28,000, in 32% between 28,001 and 55,000, in 10.2% of cases between 55,001 and 75,000, while only the 4.8% declare a family income of over 75,000.Most of the participants (55.6%) live in a large city (more than 100,000 inhabitants), while 24.2% live in a medium-sized town (between 10,000 and 100,000 inhabitants), while 20.2% live in a small town (fewer than 10,000 inhabitants).

In respect of income during COVID-19, 65.8% of women declare they have an income equal to before, while only 1.3% declare they earn more, instead 32.8% declare an income lower than before and in half of the cases sustained by state aid. The majority of women switched to smart-working (59.8%), with only 14.1% continued to carry out the previous activity in the same way, while 13.6% said they had undergone a reduction or a change of hours while the 11% say they have asked for COVID or parental leave or been laid off; only 1.5% have undergone a change of role.

METHOD AND MEASURE

The method used is a quantitative approach, the questionnaire of an exploratory nature, it follows recent reflections on the design and application of online questionnaire surveys (55). It included some areas that were identified after holding focus group meetings. The questions are based also the results of earlier research that the authors were developed during the first period of lock-down due to the pandemic COVID-19 that have involved 1,250 participants (49).

The dimensions further analyzed are:

Behavior to protect health and social distancing

- The questions related to this area were intended to investigate how women behaved to protect their health and what kind of social distancing they adopted with the people who lived with them. Both questions were multiple choice with multiple answer alternatives to choose from.

- The "Inclusion of the Other in the Self" (IOS) (56, 57): the scale is a simple pictorial tool, which is consist in two increasingly overlapping circles indicating the degree of proximity to each other. One circle represents your own self, and the other circle represents the self of another individual. We have chosen this scale to evaluate the level of closeness/social distancing between the respondent and another individual. The IOS task asked respondents ("You" in our version) to assess their relationship with a specific individual (referred to as "X" in figure proposed) by selecting one out of seven pairs of increasingly overlapping circles. In each pair of circles, one circle refers to the respondent and the other circle to X. Respondents were asked to select the pair of circles that best describes their relationship with X. For example, if a respondent feels unrelated to X, it would be natural to select the pair of still separate circles; if a respondent feels very close to X, he or she may choose the almost completely overlapping set of circles. In our study the scale was used in four versions in which the X represented: a person very close to the compiler, a neighbor, a good friend, a resident of the same neighborhood where the subject lived. The respondent had to indicate the image that most represented the term "we" to define himself and a person that she/he considered very close to himself during the lock-down by selecting the pair of separate circles from 1 (not very close) to 7 (very close), that is, the overlapping circles.

Maintaining family relationships

- The questions relating to this area were intended to investigate family relationships during the period under investigation, with attention paid to the sharing of spaces (multiple choice question with only one alternative answer to choose from and an open question in which the choice given) and moments of conviviality and socio-relational (multiple choice question with multiple alternative answers to choose from).

Neighborhood relations and collective solidarity initiatives

- This area intended to investigate neighborhood relations during the lock-down and participation in collective and/or solidarity initiatives. The two questions were formulated with different answer alternatives among which the respondent could choose more than one.

Family conflict

- Presence or not of conflict in the family with dichotomous question (yes/no).
- Causes of conflict within the family during the lock-down: multiple choice question.
- How the conflict arose during the lock-down: single choice in multiple choice question.
- Thinking about the period they lived before the pandemic, respondents had to indicate on a scale from 1 (not at all) to 5 (very much) the level of conflict between them and the people with whom they lived (partners, children, parents, siblings).

- Thinking about the period experienced during the lock-down, respondents had to indicate on a scale from 1 (not at all) to 5 (very much) the level of conflict between them and the people with whom they lived (partners, children, parents, brothers/sisters).

Socio-demographic variables

- Socio-demographic questions: age, gender, civil status, educational qualification, age range of children, type of work during the COVID-19 health emergency, income.

PROCEDURE

The questionnaire was proposed on-line, the research team sent a link by e-mail, WhatsApp, discussion forums and social networks such as Facebook to reach a larger number of women. The inclusion criteria were being at least 18 years old and living in Italy during the lock-down due to COVID-19. The sampling was random cascade and it started with women known to the researchers; hence, the sample is of convenience.

The ethics committee of the Department of Education Sciences of the University of Genoa approved the questionnaire, and the data was collected in compliance with privacy rules and the research ethics code of the Italian Association of Psychology. During the last week of the lock-down the researchers collected the data, after people had stayed 40 days in isolation in their homes. The 1st day on which the questionnaire was disseminated, it was completed more than half by participants. This data is in line with other research conducted on-line during the COVID-19 pandemic (58, 59). People took ~22 min to fill it out. At the start of compilation, there was information regarding the research objectives, the areas investigated, the type of return, informed consent, and the method for withdrawing from the study.

DATA ANALYSIS

Descriptive statistics were calculated for sociodemographic characteristics and information about variables, while the IOS scale scores were expressed as means and standard deviations. Moreover, to compare the differences between the results to IOS scale of our participants in relation to the pre-pandemic data (57) t-tests was conducted for single samples. The verification of the normal distribution of the sample was first done. T-test for paired samples, on the other hand, was used to analyse the difference in means in relation to the variables: family conflict (before and during lock-down). The Cohen's d was used to calculate the size of the effect. Finally, Chi-square analysis was performed to investigate the relation between causes of conflict and activities carried out with children and children's ages. All tests were two-tailed, with a significance level of $p < 0.05$ or $p < 0.01$. Statistical analysis was performed using SPSS Statistic 18.0. The qualitative open question was analyzed by two independent judges following the constant comparison analysis technique (60). The approach is based on grounded theory (61) and is supported by the use of the software Nvivo12 (2018).

RESULTS

Women and Health Protection During COVID-19: Behavior and Social Distancing

When asked "how do you behave to protect your health" women, in most cases (89.3%), use personal protective equipment when they go out and limit outings (75.7%), followed by: they wash their hands often (65.0%), do physical activity at home (45.7%), frequently sterilize environments and objects (32.3%), do not touch eyes, mouth, nose, ears (20.3%), check the behavior of those who live with them (20.0%), spend a lot of time in isolation in their room (6.3%), never go out (5.7%), buy only packaged things (3.7%), use personal protective equipment even when they are at home (1.7%). Considering only women living with other people in the house ($N = 260$), it emerges that in most cases (76.9%) women do not apply any kind of distancing with their family members, while 16.5% avoid kisses, 14.2% do not embrace those who live with them, 4.2% avoid sex with their partner, 2.3% live in separate rooms from others, 1.9% keep 1 m away at home, 0.4 use a mask at home.

Analyzing the data in relation to the IOS scale it emerges that the sense of closeness and the sense of "us" are higher when people refer to a close person (M = 5.0; SD = 2.0), followed by a good friend but with an average lower than the theoretical average (M = 2.74; SD = 1.94), while the neighbor and a resident of the neighborhood obtain, respectively, lower scores (M = 1.75; SD = 1.35; M = 1.47; SD = 1.06). Comparing our data with regulatory data (60) it emerges that there are no significant differences with the person considered close (M = 5.2, SD = 1.3) while both the neighbor and the resident of the neighborhood obtain lower proximity scores compared to the data relating to the Gächter study (57) with statistically significant differences in the t-test per single sample [neighbor $t(298) = -7.04$, $p < 0.001$ Cohen's d 0.42; inhabitant of the neighborhood $t(298) = -13.5$, $p < 0.001$, Cohen's d 0.70]. In both cases we compared our data with the figure of the acquaintance of Gacher's study (M = 2.3, SD = 1.3). Also, with regard to the figure of the friend during the lock-down period, the score obtained on the IOS scale is significantly lower than the measurements taken in non-lock-down periods [M = 2.74; SD = 1.94 vs. M = 3.70; SD = 1.30; $t(298) = -8.61$, $p < 0.001$; Cohen's d 0.58].

Maintaining Family Relationships

As regards family relationships, it emerges that in most cases women declared that it was better to live with their family members (52.8%) or in a couple with their partner (27.8%), and only a small part only with children (3.7%), with friends (7.4%), or alone (8.4%). If we analyse the qualitative reasons behind the choices made by women, the idea emerges that, at a time like that of the lock-down, family relationships make it possible to overcome loneliness, keep company and take care of each other. In fact, among the prevailing motivations of those who answered "better to live with family" there are elements that refer to the idea of the family as an emotional place, of sociability, mutual care, psychophysical well-being, emotional stability, contrasting stress, loneliness, and the onset of depression. The family also generates trust in the other, in their adherence to the virus protection and

containment rules, representing, for the respondents, the best and most functional group of mutual protection from contagion.

This perception transpires both from those who live only with the partner and from those who live with the partner and children but also for adult children who have been with their elderly parents. As also emerges from the research carried out during the same period by the University Center for Studies and Research on the Family, Catholic University of the Sacred Heart [(62), p. 36]: interpersonal family relationships are configured as a reservoir of sociability and trust [...] in short, families even in a period marked by objective criticalities, they are able to grasp the positive added value of the bonds in terms of share capital.

It is also interesting to note that a certain awareness emerges about the difficulties of relationships in this moment due to the forced coexistence, with some women very clearly underlining the gap between the ideal perception and the real difficulties of coexistence, highlighting the risk of tensions and conflicts where relationships were difficult before. Mirroring this, those who answered "better to live alone" (8.4%) specified, in fact, that the choice is linked, in addition to avoiding the stress of often conflicting cohabitations or in confined spaces, to the fear of the risk of being infected or of infecting "In the family one is less alone but more risky, better alone"; "Less chance of spreading the virus to elderly or at-risk relatives," "We avoid accidentally infecting sections of the population at risk."

The women highlighted how the moments of greatest sharing in the family were linked to: eating meals (89.8%), watching TV programmes (70.5%), cooking together (63.1%), playing board games (46.1%), sports (26.4%), gardening (23.7%), musical activities (singing, dancing) (20.0%), seeking information on COVID-19 (18.6%), praying together (8.8%) and meditation (3.3%).

Family Conflict: Reasons, Ways, With Whom

In relation to the dimension of family conflict, 73.4% declare that they have experienced this, in particular a relationship emerges between the conflict and the age of the children of the women [$\chi^2(5) = 15.81$, $p = 0.006$, Cramer's V = 0.36]. The highest percentage of women who perceive conflict is given by those who have children aged 18 and live at home (23.3%), 0–6 years (22.2%) and 7–11 years (20%). Percentages for the other age groups are 12.2% of those who have children between 15 and 18 years and 11.11% of those who have children between 12–14 and 18 years and do not live with them.

The main causes of family conflicts are related to: cooking and cleaning the house (33.9%), lack of privacy (25.2%), previous family problems worsened by imprisonment at home (22.5%), absence of division between working and non-working time (21.7%), use of on-line communication devices (16.1%), observance of the rules (15.7%), relationship with adult children -due to study, time spent on on-line games, use of social networks etc. (13.1%), children's homework (11.1%), childcare management (9.8%), economic problems (9.1%) and sexuality (7.7%).

Furthermore, the Chi-square analysis revealed a significant relationship with some of the different causes of conflict and the age of the children, as shown in **Table 1**.

Moreover, the family conflict manifested itself with frequent quarrels (29.8%), isolation meant as keeping a muzzle, not speaking, withdrawing from the relationship, etc. (20.4%), with verbal violence (7.6%), psychological violence (2.3%), relationship control (1.8%), other (9.7%), while for the remaining cases there was no conflict.

As for the perception of family conflict, it emerges that the major conflict is with the partner; moreover the t-test for paired samples shows how the perception of the conflict has changed during the lock-down period compared to the previous period in relation to the parental figures and to the brothers/sisters, with whom it seems to have significantly decreased, this is obviously given by the fact that during the lock-down the moments of meeting and possible conflicts with non-resident family members were considerably reduced; while with the partners and the children appears to have remained unchanged (**Table 2**).

Neighborhood Relations and Collective Solidarity Initiatives

The lock-down also had effects on the dimension of the neighborhood: 52.2% of women said they talk to neighbors from the balcony, 46.7% said they no longer frequent their neighbors in their homes, 15.9% highlighted the exchange of information, 9.7% say they shop for each other while 9.2% exchange home-cooked food products, another 9% say they have come into contact with neighbors they did not know before, alongside these positive dimensions there are also two types of rather negative relationships: mutual control to ensure that the quarantine rules are respected (4.8%) and an increase in conflict (2.7%). Regarding the collective solidarity initiatives, most women report having joined in with solidarity initiatives (72.5%), most of them claim to have participated in one activity (30.1%), two (26.5%), three (11.1%), or four (4.9). In 36.3% of cases, they "shared literary/musicalF/cinematographic advice," in 33.3% they "did the shopping for someone belonging to the categories most at risk," in 26.1% "singing while looking out on the balcony," in 19.6% "buying medicines for someone belonging to the categories most at risk," in 17.3% they "created on-line content to entertain those who were at home." Furthermore, most of the women declare that they were part, during the first lock-down in Italy, of one or more communities that came together on-line through new forms of rituals such as sport/music/dance/meditation/wellness (20.7%), discussions/workshops (18.2%), playing together (9.8%), celebrating anniversaries (6.0%), aperitifs/dinners (3.0%) or reading (2.4%).

DISCUSSION

The first Italian national lock-down started on 21 February 2020 and lasted until 3 May 2020, severely restricting citizens' freedom in order to safeguard public health.

TABLE 1 | Causes of conflict and age of children.

Causes of conflict	Age of children	%	df	χ^2	P	Cramér's V
Childcare management	0–6 years	42.9	5	34.72	0.000	0.55
	7–11 years	42.9				
	12–14 years	3.6				
	15–18 years	3.6				
	Over 18 years old and living at home	3.6				
	Over 18 years old and not living at home	3.6				
Children's homework	0–6 years	6.7	5	71.8	0.000	0.78
	7–11 years	56.7				
	12–14 years	26.7				
	15–18 years	10				
	Over 18 years old and living at home	0				
	Over 18 years old and not living at home	0				
Relationship with adult children	0–6 years	0	5	21.64	0.000	0.40
	7–11 years	11.5				
	12–14 years	15.4				
	15–18 years	23.1				
	Over 18 years old and living at home	42.3				
	Over 18 years old and not living at home	7.7				
Absence of division between working and non-working time	0–6 years	33.3	5	17.13	0.002	0.37
	7–11 years	25.9				
	12–14 years	0				
	15–18 years	22.2				
	Over 18 years old and living at home	14.8				
	Over 18 years old and not living at home	3.7				
Use of on-line communication devices	0–6 years	20	5	11.4	0.03	0.30
	7–11 years	30				
	12–14 years	20				
	15–18 years	10				
	Over 18 years old and living at home	20				
	Over 18 years old and not living at home	0				
Cooking and cleaning the house	0–6 years	26.7	5	11.39	0.04	0.30
	7–11 years	20				
	12–14 years	11.1				
	15–18 years	15.6				
	Over 18 years old and living at home	22.2				
	Over 18 years old and not living at home	4.4				

TABLE 2 | Perception of conflict before and during the lock-down with the people women live with.

		N	M(SD)	t	p	Cohen's d
Partner	Before	245	2.02 (1.03)	0.000	1.00	
	During		2.03 (1.18)			
Children	Before	173	1.82 (1.03)	0.33	0.74	
	During		1.80 (1.00)			
Parents	Before	217	2.01 (1.05)	3.94	0.000	0.27
	During		1.80 (1.06)			
Brothers/sisters	Before	201	1.83 (1.00)	4.51	0.000	0.32
	During		1.60 (0.93)			

In our sample, approximately one third of women declare an income lower than before and in half of the cases sustained from state aid, highlighting how economic suffering has also deeply affected the female gender (62–64).

During this period, the home and family relationships are perceived as a safe place, with the fear of being contaminated by the virus remaining outside the home, which accordingly becomes a protected place to take refuge. Clearly, this narrative excludes situations of domestic violence in which neither home nor forced cohabitation becomes a safe place and condition (26, 65). Outside the confines of the home, women implement recommendations and adopt behavior to prevent contagion by

using personal health protection means, limiting or completely avoiding going out, washing hands frequently, shopping on-line, but also thinking about quality of life and physical well-being, for example by doing physical activity at home, including by connecting to on-line courses. Within this scenario, the theory of self-determination (66, 67) finds strength in a gender perspective that emphasizes how individuals are proactive or passive depending on the social conditions in which they are involved and could become a good form of interpretation and support for decision makers. It is a well-known fact that the theory of self-determination emphasizes how the type or quality of a person's motivation to follow recommendations and implement recommended behavior is more important than the amount of motivation to predict significant results also in relation to psychological health and well-being (68). In particular, we see how the autonomous motivations in which people identify themselves, such as the value of distancing and use of protective devices, and which they would ideally integrate in their sense of self, compared to those controlled and imposed, produce greater adhesion and therefore develop better psychological health. Indeed, the messages proposed by the government and the WHO tried to act on this motivational level, trying to involve citizens in the choices, internalizing values and sense of individual responsibility according to an active citizenship taking the perspective of social and intergenerational solidarity, shifting attention away from self-protection and toward the protection of the community as a whole (16) and that, from the data collected, women seem to have grasped.

However, precisely because the home is considered a safe environment, physical distancing is not implemented there, even though a fair percentage of women (around 15%) reveal that they avoid closer contacts such as kisses and hugs with people living together. The data collected through the IOS scale, which indicated the degree of closeness to each other, also showed that the sense of closeness and of "us" was higher when women indicated a person they considered close than a friend, like a neighbor, highlighting a sense of increasing social distancing from intimate to social relationships. This data is even more worrying if we compare it with the data collected before the pandemic where, while the sense of closeness with the person considered as close has not changed, for all other situations (friend, neighbor, etc.) the scores obtained are, respectively, lower showing a greater sense of distance with all those outside an intimate relationship. It should be emphasized that the sense of closeness and of "us" was not to be understood in a physical sense but rather in a psychological and emotional one: the lock-down period would therefore seem to have also affected the relational dimension as a loss of recognition of both friendly and neighborhood ties and relationships, in the face of the fact that women were in any case promoters or participants in a good percentage of solidarity and collective actions, as emerges from the above data. The role of women, in literature, has already been classified as one of promoters of psychological well-being and healthy communities,

acting as creators of relational well-being within their life contexts (33).

In addition, our data shows a strong resilience of family relationships highlighting how women, in most cases, considered it important to face the lock-down with their family members or in a couple with their partner, especially in those situations where the previous relational dynamics were perceived as positive and satisfactory. It is clear from the reasons given by the women that the family was seen as an aid against the loneliness of lock-down and, where relationships were already positive, also an opportunity to spend time together outside the frenzy of everyday life. Forced isolation therefore came as an opportunity to rediscover family ties and to "do" something together. The moments of greater sharing in the family reveal a very articulated daily routine that combines routine situations such as eating meals or watching TV programmes with more creative activities such as cooking together, playing board games, playing sports, gardening, musical activities (singing, dancing) to name but a few that filled the days spent at home during the lock-down.

However, in the face of a perception of family relationships, despite the complex situation of using the rooms of the house in a new way, a high percentage of women (73.4%) claim that they experienced a dimension of family conflict. This situation appears to be related to the age of the children especially for those who had adult children still living at home or children in the 0–6 and 7–11 age groups. In these cases it is above all the management of daily life and the specific needs of non-autonomous children that has put the female gender, which is more involved in these activities than fathers, to the test (49, 69); in particular, needs in respect of material care, entertainment and also the management of distance learning have emerged. The significant relationship between family conflict perception and children's age also confirms earlier research carried out by us in the same period on a different sample and with a different data representation tool (49). As is well-known in literature, adolescence is a phase of the life cycle that is difficult to manage in general, but clearly all this has been amplified by the forced cohabitation between parents and children who normally spend a lot of time away from home in total autonomy and together with their peer group. While some authors (62, 70, 71) indicate that in part the lock-down was also an opportunity to rediscover relations between the different generations, it is plausible that some tensions have increased.

The main causes of family conflicts were related to routine domestic activities, preparing meals, cleaning the house, tidying up etc. These activities, although on the one hand presenting an opportunity to share and to spend time together, on the other hand, could be perceived as duties to be fulfilled. Activities that in pre-pandemic situations, many women and families handled turning to external services in order to reduce the burden of domestic and care tasks in the management of everyday life, especially in cases where both partners worked. Another significant aspect perceived by women as a source of conflict was the lack of privacy; the forced and continuous sharing of domestic

space (not always adequately large enough to guarantee all family members a place of their own) which in many cases has also become the workplace has created tensions and conflicts between all living together.

These aspects also emerged in research that showed how COVID-19 changed the daily routine of families (72), who found themselves forced to share a restricted space for a long period of time, carrying out activities within it, for which another location was previously destined. Therefore, the boundaries between home and work blurred, and families are experiencing a particularly stressful.

However, our data shows that conflict situations have not resulted in forms of extreme conflict but instead have been mainly concentrated in an increase of quarrels or withdrawal behavior from the relationship with the other, such as sulking or not talking.

It is also highlighted that the most commonly experienced conflict is the one with the partner or children, which in any case remains unchanged compared to the period before the lock-down, underlining a resilience of family relationships.

Shifting the focus of reading the data outside of women's family relationships shows that the lock-down also impacted the size of the neighborhood in ways some of which we have already highlighted with the results on the proximity IOS scale; although 52.2% of women say that they talk to their neighbors from the balcony, in line with the scores on the IOS scale, 46.7% state that they no longer frequent their neighbors in their homes, underlining that forced distancing which was indeed regulated by legislation but also by fears of contagion that was well-represented by the choice to represent these links as distant circles through the IOS scale.

It is evident from the results that communities, and neighborhoods themselves, have undergone and are continuing to undergo significant changes due to COVID-19 (82). At the same time, however, as also emerges from Glover's study (73), a social connection as a neighborhood has been rediscovered albeit with the necessary safety distance.

As regards collective solidarity initiatives, most women report to have joined in solidarity initiatives (72.5%), showing despite the distancing, a perceived desire to maintain ties and play an active part in community life. Many women also participate in one or more on-line communities in order to create family-based sharing and use the time available in new social and relational ways.

However, this data seemed to show a level of home environmental safety in which everything outside lost the contours of normality while everything inside assumed safe boundaries where one could protect oneself, yet today with the second wave of the epidemic the virus has entered our homes, families relationships are the highest risk. The danger of making the weakest people sick by meeting with them again returns and the issue of social responsibility and health citizenship re-emerges.

It would appear to us that these recommendations once again reinforce the idea of the family living together as a group of trust. Given voice to their point of view as women, mothers and workers facing an unprecedented experiential crisis, it allowed us to outline an interesting exploratory framework while aware of the limits of using the methodology used. In fact, the use of both random cascade sampling and online questionnaires may have hindered a wider and more diversified participation among the population; however, due to social distancing, the online data collection strategy was considered the only feasible one, which made it possible to quickly reach a rather large and geographically distributed population on the Italian territory.

CONCLUSION

The point of view of women, during the first lock-down for COVID-19 in Italy, highlights interesting reflections to be submitted to the scientific debate on the issues in question and to the attention of political debate and decision makers. The article examines the matter from a gender perspective that takes into account the point of view of women some of the problems that the Italian community had to face in the period of forced and prolonged cohabitation during the lock-down. The initial questions concern the central topic of social distancing, the maintenance of family relations, the dimension of family conflict and neighborhood relations in the dimension of collective solidarity. In the text we have discussed in detail the results obtained in every aspect of the research, and here we would like to just briefly focus attention on the multidisciplinary approach that has been the hallmark of this research and which is a strong point in terms of the effectiveness of reading the data that has emerged and which makes it possible to better identify critical points that can be a starting point for hypothesizing interventions aimed at improving political choices and intervention in a situation that continues to last indefinitely and unpredictably. The spread of the virus is showing signs of renewed vigor throughout Europe and Italy is no exception; this leads many virologists to talk about a second wave of pandemic that sees in the fragility and critical issues that emerged in our work the basis on which to intervene to avoid the increase of closure in the family dimension that now seems less secure than then and in which the fragility of the bonds inside and outside the home seem to become aspects on which to open important reflections so as not to lead women to a concrete and not very constructive, isolation. Family, social and neighborhood ties return to the center of the fear of contagion and become the protagonists of the strategies to be put in place to face the pandemic once again, which seems to have regained strength precisely in relation to the relaxation of relational precautions and the consequent abandonment of the "collective pact" that assumes health as a public asset. It would appear to us that we can interpret this as an awareness of being part of what Beck and Gernsheim (74) call the existential community of global destiny.

We believe that the results of our investigation may constitute important points of reflection for decision-makers and politicians in planning interventions and in producing compliance messages of action in which the idea of citizenship does not conflict with health and economic rights.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by University of Genova. The participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

RP, NR, IC, and FL conceived the original idea of the study and supervised the findings of this work. NR and IC contributed to data processing and analysis. All authors wrote and organized the manuscript, in particular RP and FL developed the introduction and the first and second paragraph, and NR wrote the third paragraph. While NR and IC presented the methlogy, procedure, and data section. All authors discussed the results, reviewed the document, and approved the final version for submission.

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Public Knowledge, Attitudes, and Practices Behaviors Towards Coronavirus Disease 2019 (COVID-19) During a National Epidemic—China

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Background: The rapid outbreak of coronavirus disease 2019 (COVID-19) posed a serious threat to China, followed by compulsive measures taken against the national emergency to control its further spread. This study was designed to describe residents' knowledge, attitudes, and practice behaviors (KAP) during the outbreak of COVID-19.

Methods: An anonymous online questionnaire was randomly administrated to residents in mainland China between Mar 7 and Mar 16, 2020. Residents' responses to KAP were quantified by descriptive and stratified analyses. A Multiple Logistic Regression model was employed to identify risk factors associated with KAP scores.

Results: A total of 10,195 participants were enrolled from 32 provinces of China. Participants of the ≥61 years group had higher KAP scores [adjusted Odds Ratio (ORadj) = 4.8, 95% Confidence Interval (CI): 3.0–7.7, $P < 0.0001$], and the married participants and those in low-income families had higher scores of KAP (ORadj = 1.2, 95% CI: 1.1–1.3; ORadj = 1.8, 95% CI: 1.6–2.2, respectively, both $P < 0.0001$). The participants living with more than two family members had higher scores in an increasing ORs when the family members increased (ORadj = 1.3, 95% CI: 1.1–1.6, $P = 0.013$; ORadj = 1.3, 95% CI: 1.1–1.6, $P = 0.003$; ORadj = 1.3, 95% CI: 1.0–1.6, $P = 0.02$; for groups of 2, 3–4 and ≥5, respectively).

Conclusions: Out of the enrolled participants who completed the survey, 85.5% responded positively toward the mandatory public health interventions implemented nationwide by the Chinese authorities. These effective practices seem to be related to a proper attitude generated by the increased knowledge and better awareness of the risks related to the COVID-19 pandemic and the consequent need for safe and responsible behavior.

Keywords: COVID-19, KAP, knowledge, attitude, practice, survey, China

INTRODUCTION

The Coronavirus Disease 2019 (COVID-19) has experienced an outbreak across China and other countries around the world widely involving the population and the authorities (1). Due to the rapid person-to-person transmission and the asymptomatic initial appearance, with a median incubation period of ∼ 5 days, COVID-19 has created a public health emergency of international concern. At the time we conducted our survey, ∼1,300,000 confirmed COVID-19 cases had been reported overall the world, including 80,000 deaths across more than 200 countries. Although the number of confirmed cases is still soaring around the world, China has controlled the spread of epidemic. As reported by the National Health Commission of the People's Republic of China, at the moment of preparation of this manuscript, the confirmed cases were 8,976 and the cumulative deaths were 3,226, exhibiting a striking decreasing trend (2).

The outbreak of COVID-19 creates a huge disaster to China, especially during the Chinese Annual Lunar New Year time when the people celebrate in grand pomp and the community participates for several days. Due to the spread through respiratory droplets, the initial epidemic and subsequent pandemic created an overwhelming burden on the public health emergency management system. To control the diffusion of the infection across the nation, Chinese authorities took measures and preventions to block the transmission among close contacts. Due to the lack of effective vaccines, Chinese authorities focused mainly on the strategies of public health outbreak response as community containment, quarantine, and public education (3, 4). Many gatherings were canceled and prohibited, including congresses, public events, holiday parties, etc. and traffic travel in Wuhan and cities across Hubei province was completely blocked.

In addition, education on COVID-19 was delivered to the public through various media: television, internet, and telephone. Therefore, it not only required the authorities to promptly and effectively respond to the emergency during the holiday travel time, but also required the relevant knowledge of COVID-19 be extensively absorbed by the public. Although the above measures had been successfully used in past epidemics (5, 6), it was the first time that they were administrated extensively across the whole nation. The aim was to increase the awareness of the population on the severity of the disease, reflect on the severity and need for following specific guidelines, and behave toward the pandemic in a way that would block the transmission of COVID-19.

During the outbreak of COVID-19, a nation-wide survey in China to disclose residents' knowledge, attitudes, and practices (KAPs) toward the epidemic was conducted, in order to reveal their perceptions of the risk factors, cognition, and health priorities. The aim of the study was to assess the determinants of knowledge and attitudes toward COVID-19, the practice behaviors of prevention among residents, and to disclose public attitudes toward Chinese authorities and government. Up to now, no KAP study regarding COVID-19 has been conducted in China, and this study addresses that gap. Moreover, it can present important suggestions for the authorities of other countries for what should be done to block the pandemic diffusion and the possible measures to be applied.

METHODS

Setting and Population

During the outbreak of COVID-19, an online self-administrated questionnaire was administrated randomly to residents of 32 provinces of China between March 7th and March 16th, 2020. An electronic questionnaire was distributed to the mobile phones of residents simultaneously with no stratification conducted for sampling. The survey was anonymous and without any possibility of identification.

The study was conducted according to the principles of Helsinki declaration. The bioethical committees at Fujian Medical University 2nd Affiliated Hospital, China, gave written approval for the study (2020-206).

Survey Measures

The questionnaire was optimized involving expert Chinese researchers and respiratory doctors with extensive experience in the field for designing and developing questions.

Details of the KAP questionnaire are presented in the **Supplementary Tables 1–3**, consisting in single-choice questions, multiple-choice questions, and open-ended questions. The questionnaire included four sections: Socio-demographics, Knowledge, Attitudes and Practice Behaviors of the participants. The first section focused on personal basic information, including gender, age, educational status, occupation, marital status, inhabiting status, family income and current direct or indirect involvement with COVID-19 illness. The second section consisting of eight questions regards the knowledge of the incubation period, clinical symptoms, measures of transmission, and preventions of COVID-19. In the third section, the attitudes toward COVID-19 were analyzed through ten questions. Participants who were aware of the risk of infection and practiced healthy behaviors were considered as having a positive attitude toward the epidemic. On the contrary, participants who could not or did not recognize the risk of the infection and the importance of personal protection were considered to be negative. The last section included ten questions to evaluate the practical behaviors of participants during the epidemic of COVID-19.

The knowledge, attitude, and practice measured responses of each question were analyzed by a panel of experts, and the cumulative and respective scores were calculated. A higher score indicated a more positive sensitivity toward COVID-19.

There were two open-ended questions eliciting additional comments to describe how respondents were affected by COVID, and the measures they used to keep their mood comfortable during the epidemic. The responses from the open-ended questions will be analyzed in a further study.

Statistical Analysis

An exploratory factor analysis was used to reveal the validity and factor structure of the knowledge, attitude, and practice items using principal axis factoring and varimax rotation. Descriptive statistics, including frequencies, percentages, means, and SD, were used to quantify the survey responses. The differences of KAP scores between subgroups of socio-demographic

characteristics were compared by ANOVA or Games-Howell test. Univariate and multivariate Logistic regression models were constructed to disclose the associations between the groups of KAP scores and subgroups of socio-demographic characteristics. Considering the skewed distribution, we used the median of scores as a cutoff to divide the KAP scores into the lower scores group and higher scores group. The variables adjusted in the multivariate regression models included: gender, education status, marital status, occupation, family members living together, family income, current status affected by COVID-19 and the appearance of clinical symptoms in the previous 14 days.

Based on the data, the classification and regression tree (CART) methodology models were developed to predict visual scores of KAP (7). Data analysis was completed using SPSS (version 22), python (version 3.8.0), and SAS software (9.2, Cary, NC). Figures in the study were constructed using Apache ECharts open-source library (8). All the tests were two-tailed, and values of $P < 0.01$ were considered statistically significant.

RESULTS

Socio-Demographic

A total of 10,195 participants of 32 provinces of China were enrolled through the network, with a response rate of 64.4%. The socio-characteristics of participants were described in the **Table 1**. The ages of participants to the survey ranged from 10 to 80 years old, with the average of 30.2 ± 8.5 years old. The majority of respondents are identified as female (55.4%), aged 21–40 years (80.7%), college/university educational status (59.5%), married (57.3%), living with 3–4 family members (51.3%), and lower family income (40.3%). The types of occupations were defined by the Chinese standard and the employees of commercial/service industry accounted for the largest proportion, 32.9%. 92.1% of participants stated having not, or probably not, been infected by COVID-19. The majority of participants (87.8%) did not have any clinical symptoms before 14 days before the survey.

Knowledges, Attitudes, and Practice Behaviors

The questions regarding the knowledge yielded a higher perception on COVID-19 (**Supplementary Table 1**). Approximately more than 70% reported correct perception of the transmission routes of COVID-19, and more than 88% reported clearly defined terms of "close contact." 96.4% [95% Confidence Interval (CI) = 96.0–96.8%] of participants reported having perceptions about the typical clinical symptoms of COVID-19, and 52.6% (95% CI = 51.7–53.6%) reported having the conception of its incubation period. 82.0% of responders had the correct perceptions of the measures to be taken when in close contact with confirmed cases. When fever was identified, 1.5% (95% CI = 1.2–1.7%) of respondents had awareness of wearing a mask before diagnosis was confirmed. Ninety percentage reported having the conception of preventive measures implemented by the government. Only 34.5% (95% CI = 33.6–35.5%) reported they would "visit doctors frequently" to prevent COVID-19.

Among the attitudes related to disclosure, nine questions were listed in this section (**Supplementary Table 2**). The question regarding whether COVID-19 had a serious influence on personal life yielded a "agree" and "strongly agree" response among 47.7% (95% CI = 46.8–48.6%) and 31.9% (95% CI = 31.0–32.8%) of respondents, respectively. More than 70% of participants self-rated their worrying about COVID as "a little" (51.2%, 95% CI = 50.3–52.2%) and "very worried" (19.2%, 95% CI = 18.4–20.0%). The question asking whether they were more nervous than ever after having a fever or cough yielded an "agree" and "strongly agree" response among 52.6% (95% CI = 51.6–53.5%) and 20.7% (95% CI = 19.9–21.5%) of respondents, respectively. 43.1% (95% CI = 42.1–43.9%) reported having more concern on the outbreak of COVID-19, and 49.5% (95% CI = 48.6–50.7%) reported being very concerned and being familiar with daily national epidemic trends. In addition, the affected aspects of life primarily focused on transport, working, and shopping, accounting for 87.0, 77.6, 69.5% of respondents, respectively.

Further, the question regarding the satisfaction of the control measures imposed by the government yielded an "agree" and "strongly agree" response of 45.8% (95% CI = 44.8–46.8%) and 40.2% (95% CI = 39.2–41.1%), respectively. The question asking whether individuals had faith in these control measures yielded a "have a strong confidence" and "have confidence" response among 68.4 and 25.3% of respondents, respectively. And the participants self-rated their worrying of COVID-19 as "strongly support" and "support" for the protective measures taken by the government yielded a 76.3% (95% CI = 75.4–77.1%) and 21.8% (95% CI = 21.0–22.6%) of respondents, respectively. Compared with younger people, participants in the ≥61 age group had higher scores on the three questions ($P < 0.01$) (**Supplementary Table 4**). Participants with college/university educational level were subject to have higher scores of these than those with lower educational levels ($P < 0.001$). The married had higher scores of these than other groups ($P < 0.001$). And the participants with family income ranging from 130,000 to 250,000 also had higher scores on these questions ($P < 0.05$). From the questions mentioned above, we divided the participants into two groups according to the median scores of KAP.

Additionally, nine questions of practice behaviors were listed (**Supplementary Table 3**). The vast majority of respondents (91.3%, 95% CI = 90.8–91.8%) chose to stay at home during the Lunar New Year holidays, instead of gathering and celebrating outside. 85.5% (95% CI = 84.7–86.2%) chose not to go out even though they were invited by friends. In cases when it was necessary, 87.9% (95% CI = 87.2–88.5%) reported that they kept one-meter distance from each other, and 94.7% (95% CI = 94.3–95.1%) reported that they used a mask for personal protection. However, only 63.1% (95% CI = 62.2–64.0%) of respondents were able to identify that the most correct measures to deal with a used disposable mask was to dispose it into designed dustbin of the community. Secondly, the majority of participants, accounting for 93.0% (95% CI = 92.5–93.5%), made social contact through networks. 5.1% (95% CI = 4.7–5.5%) met friends face to face. Of the total participants, 92.4% (95% CI = 91.9–93.0%) reported usually opening windows for ventilation, and 93.1% (95% CI = 92.6–93.5%) reported choosing household

TABLE 1 | The distribution of participants stratified by socio-demographic characteristics, and the stratified analysis by Univariate and multivariate logistic regression model.

		Univariate logistic regression		Multivariate logistic regression	
	No. (%; 95% CI)	OR (95% CI)	*P*-value	OR (95% CI)	*P*-value
Gender					
Male	4,557 (44.6; 43.7–45.6)	1.00		1.00	
Female	5,638 (55.4; 54.4–56.3)	1.02 (0.94–1.10)	0.705	1.09 (1.00–1.18)	0.058
Age, years					
≤20	1,079 (10.6; 10.0–11.2)	1.00		1.00	
21–40	8,224 (80.7; 80.0–81.4)	2.88 (2.51–3.29)	<0.0001	2.09 (1.80–2.43)	<0.0001
41–60	804 (7.9; 7.4–8.5)	2.49 (2.06–3.00)	<0.0001	2.21 (1.79–2.72)	<0.0001
≥61	88 (0.9; 0.7–1.0)	3.62 (2.31–5.68)	<0.0001	4.78 (2.96–7.72)	<0.0001
Educational status					
No formal education/Primary	144 (1.4; 1.2–1.6)	1.00		1.00	
Junior	892 (8.7; 8.2–9.3)	1.58 (1.07–2.31)	0.020	1.30 (0.86–1.95)	0.213
Senior	2,758 (27.1; 26.1–27.9)	2.10 (1.46–3.03)	<0.0001	1.72 (1.16–2.55)	0.007
College/University	6,063 (59.5; 58.5–60.4)	3.59 (2.50–5.16)	<0.0001	2.58 (1.74–3.82)	<0.0001
Graduate or above	338 (3.3; 3.0–3.6)	4.47 (2.93–6.82)	<0.0001	3.27 (2.07–5.15)	<0.0001
Marital status					
Single	4,130 (40.5; 39.5–41.5)	1.00		1.00	
Married	5,839 (57.3; 56.2–58.2)	1.39 (1.29–1.51)	<0.0001	1.18 (1.08–1.29)	<0.001
Divorced	191 (1.9; 1.6–2.1)	0.67 (0.50–0.90)	0.008	0.80 (0.58–1.10)	0.169
Widowed	35 (0.3; 0.2–0.5)	0.35 (0.16–0.75)	0.007	0.43 (0.19–0.97)	0.042
Occupations					
Managers of government/enterprise	1,095 (10.7; 10.1–11.3)	1.00		1.00	
Professionals	1,448 (14.2; 13.5–14.9)	1.46 (1.24–1.71)	<0.0001	1.46 (1.24–1.73)	<0.0001
Clerks	948 (9.3; 8.7–9.9)	0.99 (0.83–1.18)	0.937	0.95 (0.79–1.14)	0.595
Employees of commercial/service industry	3,361 (33.0; 32.1–33.9)	0.99 (0.87–1.14)	0.944	1.12 (0.97–1.30)	0.121
Workers in agriculture/forestry/animal husbandry/fishing/ water conservancy	448 (4.4; 4.0–4.8)	0.75 (0.60–0.93)	0.009	0.98 (0.78–1.24)	0.872
Operators of production/transportation equipment	555 (5.4; 5.0–5.9)	1.49 (1.21–1.84)	<0.0001	1.54 (1.23–1.92)	<0.001
Polices/Militaries/Guards	47 (0.5; 0.3–0.6)	0.28 (0.14–0.54)	<0.0001	0.44 (0.21–0.88)	0.020
Others	1,102 (10.8; 10.2–11.4)	0.73 (0.62–0.87)	<0.0001	0.86 (0.72–1.03)	0.103
Unemployed	1,191 (11.7; 11.1–12.3)	0.54 (0.46–0.64)	<0.0001	0.82 (0.68–0.98)	0.033
Family members living together (No.)					
Single	596 (5.8; 5.4–6.3)	1.00		1.00	
1	378 (3.7; 3.3–4.1)	0.97 (0.75–1.26)	0.843	0.94 (0.71–1.23)	0.643
2	2,166 (21.2; 20.5–22.0)	1.50 (1.25–1.80)	<0.0001	1.28 (1.05–1.56)	0.013
3–4	5,226 (51.3; 50.2–52.2)	1.58 (1.33–1.87)	<0.0001	1.33 (1.10–1.60)	0.003
≥5	1,829 (17.9; 17.2–18.7)	1.48 (1.23–1.79)	<0.0001	1.27 (1.03–1.55)	0.023
Family incomes (rmb per year)					
<50,000	2,935 (28.8; 27.9–29.7)	1.00		1.00	
50,000–120,000	4,112 (40.3; 39.3–41.2)	1.77 (1.62–1.96)	<0.0001	1.43 (1.29–1.58)	<0.0001
130,000–170,000	1,683 (16.5; 15.8–17.2)	2.16 (1.91–2.44)	<0.0001	1.72 (1.50–1.96)	<0.0001
180,000–250,000	930 (9.1; 8.6–9.7)	2.36 (2.03–2.75)	<0.0001	1.82 (1.55–2.15)	<0.0001
>250,000	535 (5.2; 4.8–5.7)	1.77 (1.47–2.13)	<0.0001	1.40 (1.14–1.70)	0.001
Current status affected by COVID-19					
Diagnosed, and cured	40 (0.4; 0.3–0.5)	1.00		1.00	
Diagnosed, and under treatment	46 (0.5; 0.3–0.6)	0.32 (0.06–1.74)	0.185	0.25 (0.05–1.39)	0.113
Suspected, and quarantined	93 (0.9; 0.7–1.1)	2.17 (0.76–6.21)	0.149	1.67 (0.57–4.89)	0.347
Home-based quarantine	218 (2.1; 1.9–2.4)	3.60 (1.36–9.57)	0.010	2.67 (0.98–7.22)	0.054
Confirmed healthy after quarantine	410 (4.0; 3.6–4.4)	11.40 (4.37–29.71)	<0.0001	8.26 (3.11–21.93)	<0.001
None of above	9,388 (92.1; 91.5–92.6)	8.51 (3.33–21.73)	<0.0001	5.49 (2.10–14.31)	0.0001
Appearance of clinical symptoms in previous 14 days*					
No	8,952 (87.8; 87.2–88.5)	1.00		1.00	
Yes	1,243 (12.2; 11.5–12.8)	0.60 (0.53–0.68)	<0.0001	0.67 (0.58–0.77)	<0.0001

*Referred to symptoms of fever, cough, expectoration, diarrhea, weak, headache, runny nose, rhinobyon, sore throat.
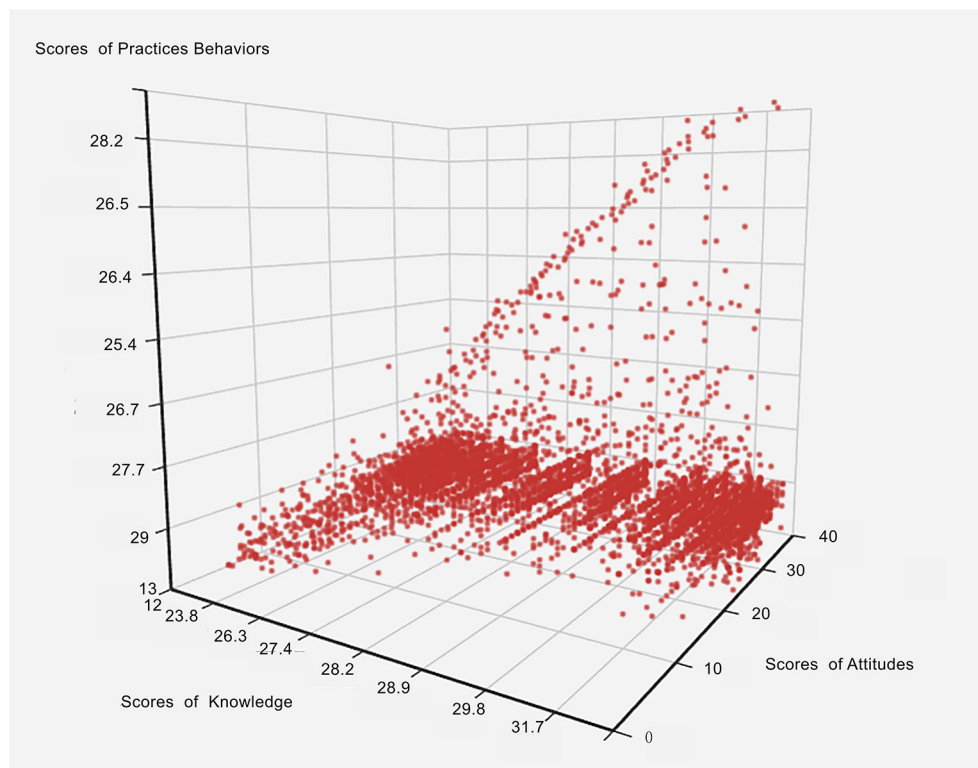
FIGURE 1 | The distributions of scores on knowledge, attitude, and practice manifested by 3D scatter. X axis represents the scores of knowledge, Y axis represents the scores of attitudes, and Z axis represents the scores of practices.

quarantine, and 94.2% (95% CI = 93.7–94.6%) reported wearing a face mask while going out, while 10.1% (95% CI = 9.4–10.7%) reported not taking any protective measures.

For personal daily life, 59.4% (95% CI = 58.4–60.3%) reported shopping for daily necessities by ordering online, and 36.3% (95% CI = 35.4–37.3%) reported doing it under the assistance of community volunteers. 47.0% (95% CI = 46.0–48.9%) reported going shopping by themselves at a market or supermarket. People during the epidemic moved on foot and in private cars, accounting for 57.5% (95% CI = 56.6–58.4%) and 55.6% (95% CI = 54.6–56.5%) of participants, respectively. Participants used public vehicles, such as taxis (9.7%, 95% CI: 9.1–10.2%), buses, and subways (11.5%, 95% CI: 10.8–12.1%).

Scores on KAP

The distributions of scores of knowledge, attitude and practice, were manifested by 3D scatter (**Figure 1**). To illustrate the distributions of scores among different provinces in China, the average scores of participants are illustrated by pie chart in **Figure 2**. Totally, the mean score of KAP was 83.3 ± 10.8, and fourteen provinces have higher scores than this, including Hubei province (**Figure 2A**). In an analysis according to each section of knowledge, attitude, and practice, the mean score was 28.4 ± 6.0, 28.2 ± 3.9, and 26.6 ± 4.1, respectively (**Figures 2B–D**).

Univariate and multivariate Logistic regression models were used to identify the risk of socio-characteristics of KAP (**Table 1**).

The analysis highlighted that the older group had higher scores of KAP than those of the younger group (all $P < 0.001$). The participants of the ≥61 group had the highest Odds Ratio (OR) of 4.78 after adjustment for other variables (for instance, gender, education status, marital status, occupation, family member living together, family income, current status affected by COVID-19, and the appearance of clinical symptoms in the previous 14 days). Participants with higher educational levels (college/university and graduate or above) were subject to have higher scores on KAP than those with lower educational levels ($OR_{adj} = 1.72$, 95% CI 1.16–2.55, $P = 0.01$; $OR_{adj} = 2.58$, 95% CI 1.74–3.82, $P < 0.001$; $OR_{adj} = 3.27$, 95% CI 2.07–5.15, $P < 0.001$; for groups of senior, college/university, and graduate or above, respectively). In addition, those married participants, accounting for the largest proportions, showed higher scores on KAP ($OR_{adj} = 1.18$, 95% CI = 1.08–1.29, $P < 0.001$). Participants living with more than two family members were linked to higher scores in an increasing ORs when the family members increased ($OR_{adj} = 1.28$, 95% CI = 1.05–1.56, $P = 0.01$; $OR_{adj} = 1.33$, 95% CI = 1.10–1.60, $P < 0.01$; $OR_{adj} = 1.27$, 95% CI = 1.03–1.55, $P = 0.02$; for groups of 2, 3–4, and ≥5, respectively). Comparing with participants in low-income families, the 130,000–170,000 rmb group had the highest scores on KAP ($OR_{adj} = 1.72$, 95% CI 1.50–1.96, $P < 0.001$). The participants with the appearance of clinical symptoms in the previous 14 days, such as fever, cough, runny nose, accounting for 87.8% of participants, responded with
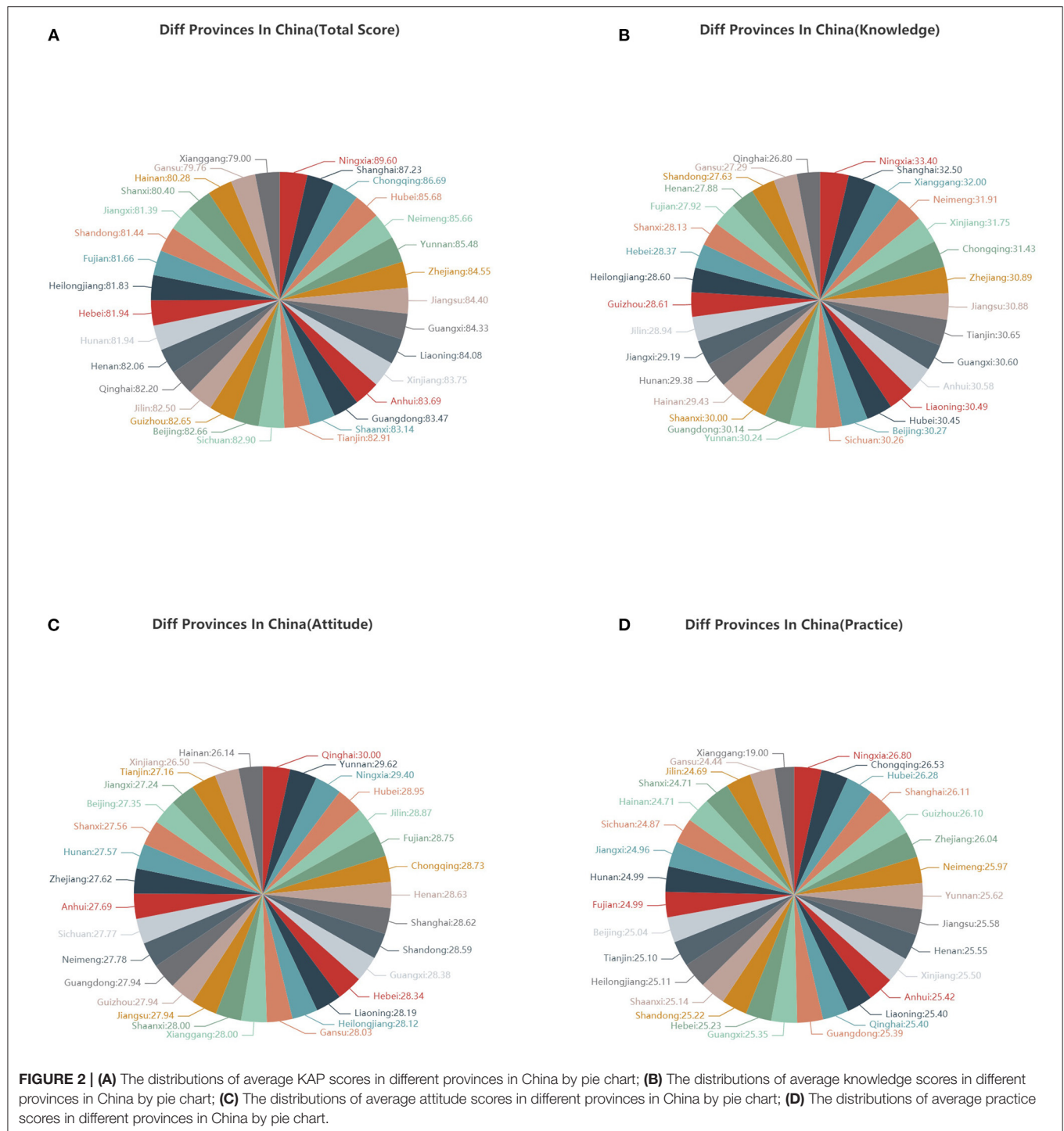
FIGURE 2 | (A) The distributions of average KAP scores in different provinces in China by pie chart; **(B)** The distributions of average knowledge scores in different provinces in China by pie chart; **(C)** The distributions of average attitude scores in different provinces in China by pie chart; **(D)** The distributions of average practice scores in different provinces in China by pie chart.

an association with lower scores of KAPs (OR_{adj} = 0.67, 95% CI = 0.58–0.77, $P < 0.001$).

Subgroup Analysis

For the stratified analyses (**Tables 2–4**), the associations between subgroups of socio-characteristics and scores on each section of

knowledge, attitude, and practice were identified by univariate and multivariate Logistic regression models.

By comparison, the participants in the ≥61 year age group were linked to higher scores on knowledge, attitude and practice (all $P_{adj} < 0.01$). Participants with college/university and graduate/above education had significantly greater awareness and practice (all $P_{adj} < 0.01$). The subgroups of occupational

TABLE 2 | Univariate and multivariate logistic regression analysis assessing scores of COVID-19 knowledge stratified by socio-demographic characteristics of residents, China.

	SCORES	Univariate logistic regression		Multivariate logistic regression	
	(Mean ± SD)	OR (95% CI)	*P*-value	OR (95% CI)	*P*-value
Gender					
Male	28.5 ± 6.5	1.00		1.00	
Female	28.3 ± 5.6	0.74 (0.68–0.80)	<0.0001	0.87 (0.80–0.95)	0.0202
Age, years					
≤20	26.8 ± 6.0	1.00		1.00	
21–40	28.7 ± 5.9	1.87 (1.64–2.14)	<0.0001	1.52 (1.30–1.77)	<0.0001
41–60	27.4 ± 6.6	1.29 (1.07–1.56)	0.008	1.42 (1.15–1.76)	0.001
≥61	29.3 ± 4.2	1.97(1.27–3.04)	0.002	3.29 (2.05–5.27)	<0.0001
Education status					
No formal education/Primary	21.7 ± 8.6	1.00		1.00	
Junior	24.7 ± 6.9	1.37(0.88–2.13)	0.158	1.39 (0.88–2.21)	0.162
Senior	27.1 ± 6.0	2.49 (1.64–3.79)	<0.0001	2.28 (1.46–3.55)	<0.0001
College/University	29.7 ± 5.2	5.50 (3.63–8.33)	<0.0001	4.19 (2.69–6.53)	<0.0001
Graduate or above	29.8 ± 6.4	8.14 (5.09–13.03)	<0.0001	5.73 (3.48–9.44)	<0.0001
Marital status					
Single	28.5 ± 6.0	1.00		1.00	
Married	28.6 ± 5.8	1.02 (0.94–1.10)	0.677	0.96 (0.87–1.05)	0.363
Divorced	24.2 ± 7.7	0.42 (0.31–0.58)	<0.0001	0.56 (0.40–0.79)	0.001
Widowed	20.2 ± 9.3	0.36 (0.17–0.77)	0.009	0.42 (0.18–0.98)	0.046
Occupations					
Managers of government/enterprise	28.8 ± 6.3	1.00		1.00	
Professionals	29.9 ± 6.0	1.47 (1.25–1.73)	<0.0001	1.49 (1.26–1.76)	<0.0001
Clerks	28.6 ± 6.7	1.00 (0.84–1.19)	0.960	1.00 (0.83–1.20)	0.972
Employees of commercial/service industry	28.3 ± 5.2	0.67 (0.58–0.77)	<0.0001	0.85 (0.74–0.99)	0.031
Workers in agriculture/forestry/animal husbandry/fishing/water conservancy	26.4 ± 8.3	0.75 (0.61–0.94)	0.012	1.16 (0.92–1.47)	0.216
Operators of production/transportation equipment	29.5 ± 6.7	1.47 (1.19–1.83)	<0.0001	1.66 (1.33–2.07)	<0.0001
Polices/Militaries/Guards	23.4 ± 7.9	0.30 (0.15–0.58)	<0.0001	0.41 (0.20–0.82)	0.009
Others	27.7 ± 5.2	0.56 (0.47–0.66)	<0.0001	0.79 (0.66–0.94)	0.009
Unemployed	27.4 ± 5.9	0.59 (0.50–0.69)	<0.0001	1.05 (0.87–1.27)	0.601
Family members living together (No.)					
Single	27.6 ± 6.2	1.00		1.00	
1	26.2 ± 6.8	0.73 (0.56–0.95)	0.019	0.77 (0.58–1.03)	0.079
2	28.6 ± 6.5	1.50 (1.25–1.80)	<0.0001	1.33 (1.09–1.63)	0.005
3–4	28.6 ± 5.9	1.35 (1.14–1.61)	0.001	1.21 (1.00–1.46)	0.047
≥5	28.3 ± 5.5	1.13 (0.94–1.36)	0.195	1.10 (0.89–1.35)	0.368
Family incomes (rmb per year)					
<50,000	26.4 ± 6.1	1.00		1.00	
50,000–120,000	29.0 ± 5.5	2.36 (2.14–2.60)	<0.0001	1.85 (1.66–2.05)	<0.0001
130,000–170,000	29.8 ± 5.7	3.21 (2.84–3.64)	<0.0001	2.34 (2.04–2.68)	<0.0001
180,000–250,000	29.6 ± 6.4	3.37 (2.89–3.93)	<0.0001	2.37(2.01–2.79)	<0.0001
>250,000	28.6 ± 6.6	2.41 (2.00–2.90)	<0.0001	1.71(1.40–2.09)	<0.0001
Current status affected by COVID-19					
Diagnosed, and cured	18.9 ± 9.6	1.00		1.00	
Diagnosed, and under treatment	16.3 ± 8.3	0.58 (0.17–1.98)	0.380	0.43 (0.12–1.52)	0.188
Suspected, and quarantined	20.0 ± 9.9	2.03 (0.80–5.14)	0.135	1.48 (0.56–3.88)	0.427
Home-based quarantine	23.4 ± 9.7	2.63 (1.10–6.22)	0.028	2.11 (0.86–5.17)	0.102
Confirmed healthy after quarantine	29.6 ± 6.2	8.71 (3.76–20.18)	<0.0001	7.23 (3.01–17.35)	<0.0001
None of above	28.7 ± 5.6	4.49 (1.99–10.17)	<0.0001	4.06 (1.73–9.56)	0.001
Appearance of clinical symptoms in previous 14 days[*]					
No	28.7 ± 5.5	1.00		1.00	
Yes	26.1 ± 8.5	0.90 (0.79–1.01)	0.066	0.91 (0.79–1.05)	0.200

OR, odds ratio; CI, confidence interval.

[*]Referred to symptoms of fever, cough, expectoration, diarrhea, weak, headache, runny nose, rhinobyon, sore throat.

TABLE 3 | Univariate and multivariate logistic regression assessing scores of attitudes toward COVID-19 by socio-demographic characteristics of residents.

	Attitudes	Univariate logistic regression		Multivariate logistic regression	
	(Mean ± SD)	OR (95% CI)	*P*-value	OR (95% CI)	*P*-value
Gender					
Male	27.9 ± 4.2	1.00		1.00	
Female	28.5 ± 3.7	1.20 (1.11–1.30)	<0.0001	1.14 (1.05–1.24)	0.011
Age, years					
≤20	26.6 ± 4.1	1.00		1.00	
21–40	28.4 ± 3.8	2.29 (1.98–2.66)	<0.0001	1.92 (1.63–2.25)	<0.0001
41–60	28.8 ± 3.8	2.70 (2.22–3.29)	<0.0001	2.25 (1.82–2.79)	<0.0001
≥61	28.7 ± 3.5	2.15 (1.37–3.36)	0.001	2.09 (1.31–3.34)	0.002
Education status					
No formal education/Primary	26.0 ± 6.6	1.00		1.00	
Junior	28.2 ± 4.3	1.31 (0.90–1.89)	0.157	1.00 (0.68–1.24)	0.997
Senior	28.3 ± 3.9	1.31 (0.92–1.86)	0.138	1.06 (0.73–1.55)	0.746
College/University	28.3 ± 3.7	1.27 (0.90–1.80)	0.178	1.00 (0.69–1.45)	0.994
Graduate or above	28.1 ± 4.0	1.37 (0.91–2.06)	0.129	1.13 (0.73–1.74)	0.587
Marital status					
Single	27.8 ± 4.0	1.00		1.00	
Married	28.6 ± 3.8	1.40 (1.29–1.52)	<0.0001	1.16 (1.06–1.27)	0.002
Divorced	27.7 ± 4.6	1.19 (0.88–1.60)	0.257	1.15 (0.85–1.57)	0.369
Widowed	24.5 ± 6.2	0.46 (0.20–1.05)	0.066	0.48 (0.20–1.14)	0.096
Occupations					
Managers of government/enterprise	28.0 ± 4.3	1.00		1.00	
Professionals	28.3 ± 4.0	1.13 (0.97–1.33)	0.128	1.12 (0.95–1.32)	0.188
Clerks	28.0 ± 4.0	0.99 (0.83–1.18)	0.903	0.96 (0.80–1.15)	0.629
Employees of commercial/service industry	28.7 ± 3.6	1.24 (1.08–1.42)	0.003	1.18 (1.02–1.37)	0.022
Workers in agriculture/forestry/animal husbandry/fishing/water conservancy	27.3 ± 4.6	0.85 (0.67–1.07)	0.156	0.87 (0.68–1.10)	0.230
Operators of production/transportation equipment	28.6 ± 3.7	1.19 (0.97–1.47)	0.005	1.14 (0.92–1.41)	0.221
Polices/Militaries/Guards	25.7 ± 4.1	0.33 (0.15–0.71)	0.01	0.46 (0.21–1.02)	0.056
Others	28.4 ± 3.7	1.10 (0.93–1.31)	0.271	1.04 (0.87–1.24)	0.705
Unemployed	27.4 ± 3.9	0.70 (0.59–0.83)	<0.0001	0.75 (0.62–0.91)	0.003
Family members living together (No.)					
Single	27.4 ± 4.6	1.00		1.00	
1	27.7 ± 4.5	1.13 (0.86–1.49)	0.369	1.06 (0.80–1.40)	0.702
2	28.0 ± 3.9	1.32 (1.08–1.59)	0.005	1.23 (1.01–1.50)	0.043
3–4	28.3 ± 3.8	1.47 (1.23–1.76)	<0.0001	1.34 (1.11–1.62)	0.002
≥5	28.6 ± 3.7	1.60 (1.32–1.95)	<0.0001	1.40 (1.14–1.72)	0.001
Family incomes (rmb per year)					
<50,000	28.1 ± 4.1	1.00		1.00	
50,000–120,000	28.3 ± 3.7	1.01 (0.91–1.11)	0.884	0.94 (0.85–1.04)	0.226
130,000–170,000	28.2 ± 4.0	1.00 (0.88–1.23)	0.975	0.97 (0.85–1.10)	0.606
180,000–250,000	28.5 ± 3.7	1.17 (1.00–1.35)	0.045	1.12 (0.95–1.31)	0.173
>250,000	28.5 ± 4.1	1.26 (1.04–1.51)	0.016	1.21 (1.00–1.47)	0.052
Your current status affected by COVID-19					
Diagnosed, and cured	21.3 ± 7.1	1.00		1.00	
Diagnosed, and under treatment	20.6 ± 4.4	0.21 (0.04–1.10)	0.065	0.21 (0.04–1.09)	0.063
Suspected, and quarantined	23.8 ± 4.5	0.63 (0.23–1.77)	0.383	0.59 (0.21–1.67)	0.318
Home-based quarantine	25.7 ± 4.8	1.40 (0.59–3.36)	0.448	1.19 (0.49–2.87)	0.702
Confirmed healthy after quarantine	28.2 ± 3.9	3.24 (1.40–7.50)	0.006	2.70 (1.15–6.29)	0.022
None of above	28.4 ± 3.7	3.24 (1.43–7.32)	0.005	2.34 (1.02–5.36)	0.045
Appearance of clinical symptoms in previous 14 days*					
No	28.5 ± 3.7	1.00		1.00	
Yes	26.6 ± 4.9	0.65 (0.57–0.74)	<0.0001	0.80 (0.69–0.92)	0.002

*Referred to symptoms of fever, cough, expectoration, diarrhea, weak, headache, runny nose, rhinobyon, sore throat.

TABLE 4 | Univariate and multivariate logistic regression assessing scores of practices regarding COVID-19 by socio-demographic characteristics of residents.

	Practices	Univariate logistic regression		Multivariate logistic regression	
	(Mean ± SD)	OR (95% CI)	P-value	OR (95% CI)	P-value
Gender					
Male	26.3 ± 4.5	1.00		1.00	
Female	26.9 ± 3.7	1.07 (0.98–1.16)	0.115	1.05 (0.97–1.14)	0.252
Age, years					
≤20	25.3 ± 4.5	1.00		1.00	
21–40	26.8 ± 4.0	1.91 (1.66–2.21)	<0.0001	1.54 (1.31–1.80)	<0.0001
41–60	26.8 ± 4.1	1.84 (1.51–2.24)	<0.0001	1.54 (1.24–1.90)	<0.0001
≥61	27.1 ± 3.2	1.87 (1.19–2.92)	0.006	1.93 (1.21–3.10)	0.006
Education status					
No formal education/Primary	23.2 ± 6.2	1.00		1.00	
Junior	25.9 ± 4.8	1.83 (1.22–2.75)	0.004	1.39 (0.91–2.13)	0.138
Senior	26.4 ± 4.3	1.97 (1.33–2.91)	0.001	1.50 (0.9–2.26)	0.060
College/University	26.9 ± 3.8	2.14 (1.45–3.15)	<0.0001	1.50 (0.99–2.26)	0.058
Graduate or above	26.5 ± 4.5	2.29 (1.47–3.56)	<0.0001	1.67 (1.05–2.66)	0.035
Marital status					
Single	26.3 ± 4.1	1.00		1.00	
Married	27.0 ± 3.9	1.32 (1.22–1.44)	<0.0001	1.17 (1.06–1.28)	0.001
Divorced	24.3 ± 6.2	0.78 (0.57–1.08)	0.130	0.86 (0.62–1.19)	0.358
Widowed	18.8 ± 7.5	0.11 (0.03–0.47)	0.003	0.15 (0.03–0.62)	0.009
Occupations					
Managers of government/enterprise	26.5 ± 4.2	1.00		1.00	
Professionals	26.9 ± 4.1	1.23 (1.05–1.44)	0.011	1.19 (1.01–1.40)	0.035
Clerks	26.5 ± 4.4	1.08 (0.91–1.29)	0.387	1.03 (0.86–1.23)	0.769
Employees of commercial/service industry	27.0 ± 3.7	1.06 (0.92–1.22)	0.425	1.03 (0.89–1.19)	0.692
Workers in agriculture/forestry/animal husbandry/fishing/water conservancy	25.1 ± 5.7	0.87 (0.70–1.10)	0.248	0.96 (0.75–1.21)	0.756
Operators of production/transportation equipment	26.9 ± 4.1	1.18 (0.96–1.46)	0.111	1.13 (0.92–1.40)	0.257
Polices/Militaries/Guards	22.6 ± 5.9	0.28 (0.12–0.63)	0.002	0.38 (0.17–0.88)	0.023
Others	27.0 ± 3.6	0.95 (0.80–1.13)	0.548	0.91 (0.76–1.09)	0.335
Unemployed	25.9 ± 4.2	0.67 (0.57–0.80)	<0.0001	0.75 (0.62–0.91)	0.003
Family members living together (No.)					
Single	25.8 ± 4.5	1.00		1.00	
1	25.9 ± 4.9	0.96 (0.73–1.27)	0.776	0.93 (0.70–1.23)	0.609
2	26.4 ± 4.4	1.18 (0.98–1.43)	0.089	1.06 (0.87–1.29)	0.589
3–4	26.8 ± 4.0	1.38 (1.15–1.65)	<0.0001	1.20 (1.00–1.45)	0.056
≥5	27.0 ± 3.8	1.37 (1.13–1.66)	0.002	1.18 (0.96–1.45)	0.118
Family incomes (rmb per year)					
<50,000	26.2 ± 4.2	1.00		1.00	
50,000–120,000	25.0 ± 3.4	1.24 (1.13–1.37)	<0.0001	1.13 (1.02–1.26)	0.023
130,000–170,000	26.9 ± 3.7	1.45 (1.28–1.64)	<0.0001	1.34 (1.17–1.53)	<0.0001
180,000–250,000	26.8 ± 4.2	1.33 (1.14–1.54)	<0.0001	1.20 (1.02–1.41)	0.026
>250,000	26.5 ± 4.7	1.13 (0.94–1.37)	0.205	1.04 (0.85–1.27)	0.696
Current status affected by COVID-19					
Diagnosed, and cured	18.9 ± 5.4	1.00		1.00	
Diagnosed, and under treatment	17.7 ± 4.6	0.79 (0.15–4.19)	0.780	0.90 (0.12–4.22)	0.88
Suspected, and quarantined	20.4 ± 6.8	2.56 (0.70–9.35)	0.154	2.58 (0.7–9.53)	0.154
Home-based quarantine	22.7 ± 6.5	3.30 (0.97–11.18)	0.055	2.76 (0.80–9.44)	0.107
Confirmed healthy after quarantine	26.5 ± 4.7	8.65 (2.62–28.51)	<0.0001	6.70 (2.01–22.32)	0.002
None of above	26.9 ± 3.8	8.09 (2.49–26.25)	0.001	4.57 (1.39–15.02)	0.012
Appearance of clinical symptoms in previous 14 days*					
No	27.0 ± 3.7	1.00		1.00	
Yes	24.0 ± 5.7	0.45 (0.39–0.51)	<0.0001	0.48 (0.41–0.57)	<0.0001

*Referred to symptoms of fever, cough, expectoration, diarrhea, weak, headache, runny nose, rhinobyon, sore throat.

FIGURE 3 | (A) Predictive scores of KAP calculated by CART model; **(B)** Predictive scores of knowledge scores calculated by CART model; **(C)** Predictive scores of attitude scores calculated by CART model; **(D)** Predictive scores of practice scores calculated by CART model.
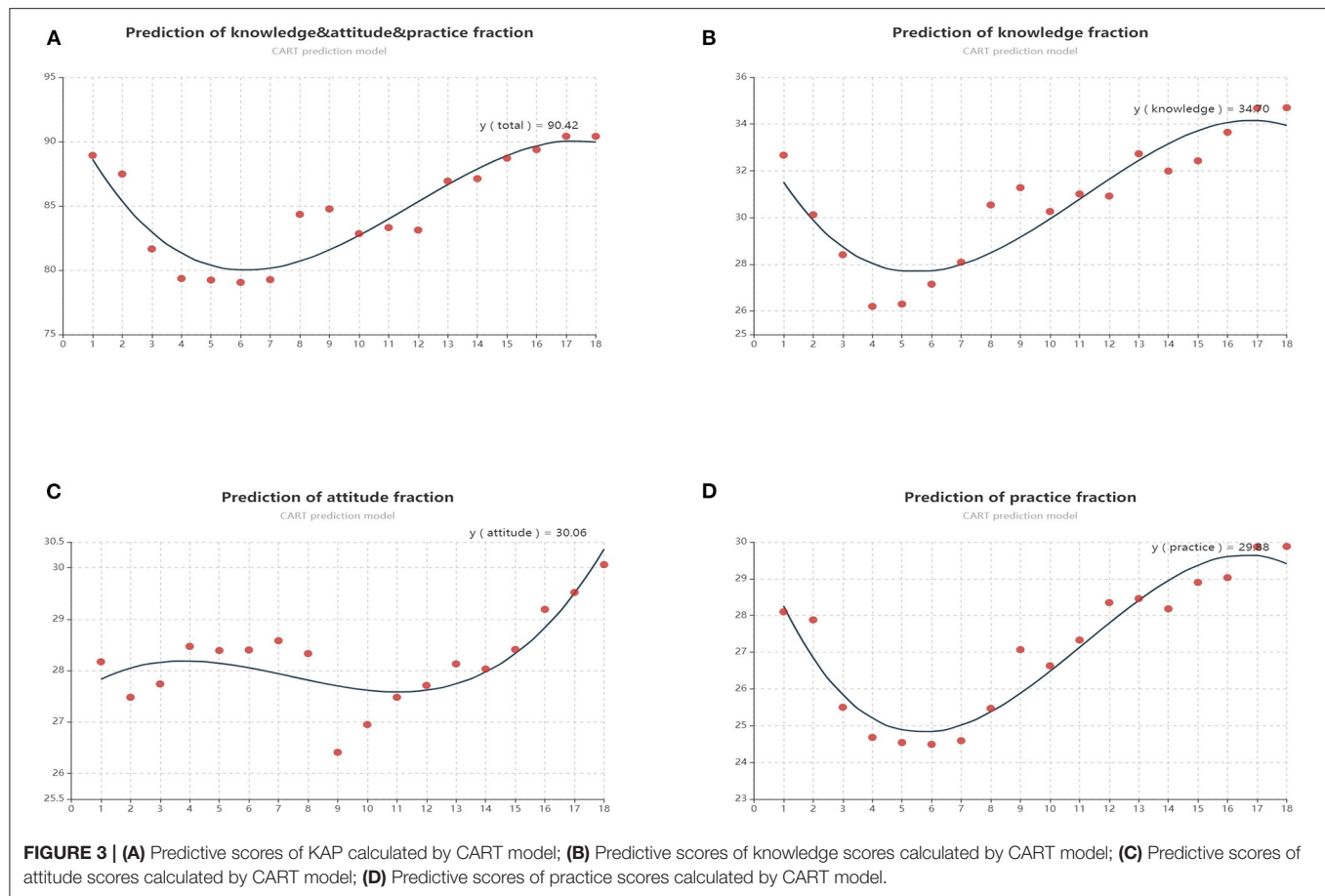
types, professionals and operators of production/transportation equipment, both of which tended to achieve higher scores of knowledge (both $P_{adj} < 0.01$).

From the study, it was revealed that the married and participants living with more than five family members were prone to achieve higher scores of knowledge, attitude and practice than other groups (all $P_{adj} < 0.01$). In the subgroup analysis of family incomes, participants of 130,000–170,000 groups achieved higher groups of knowledge and practice (both $P_{adj} < 0.01$).

During the epidemic of COVID-19, those participants confirmed healthy after quarantine and those without quarantine or diagnosis were linked to higher score on knowledge, attitude and practice (all $P_{adj} < 0.01$). Those participants without any clinical symptoms, such as fever, cough, runny nose, and sputum, were prone to achieve higher scores of attitude and practices (all $P_{adj} < 0.01$).

CART Model Construction

Additionally, a CART model was used to build predication relationships between answer time of completing questionnaires and scores of KAP (**Figure 3A**). The CART procedure was done in the model by building a set of participants using the answer time of the questionnaire as a potential predictor. CART selected a peak cutoff score of 90.4 for no further

evaluation. Moreover, analysis revealed that the predictive scores of knowledge, attitude and practice section was 34.7, 30.1, and 29.9, respectively (**Figures 3B–D**).

DISCUSSION

During the epidemic of COVID-19, we used a random sampling method to assess residents' knowledge, attitudes, and practice behaviors toward COVID-19 in 32 provinces of China. Overall, a better response toward COVID-19 accrued from the participants who were married, those with middle family income, and those who lived with more than two family members. The majority of these participants were able to recognize symptoms and the transmission risk of COVID-19.

During the Chinese Spring Festival, travel bans, lockdowns and movement restrictions were implemented across the whole nation, which disproportionately affected the residents who were without sufficient social and family support, including those who were homeless, incarcerated, migrants, or refugees (9, 10). Those residents might not have regular access to basic hygiene knowledge or supplies, which made them susceptible to virus transmission. During the epidemic, the vast majority of residents chose to stay at home with their family members, which created more opportunities and time to care and support for each other.

Survey results revealed that the married participants and those living with more than two family members received better social and family support, because it appeared not only to increase positive mental health-related lifestyle changes (11, 12), but also be conducive to health education.

Furthermore, the results of this study indicated that both educational levels and family incomes were linked to the cognition of COVID-19. Participants with higher than college/university educational levels, accounting for the largest proportions of participants, and participants with family income of 130,000–170,000 rmb per year, both displayed a better response to knowledge and practice toward COVID-19. These residents make up the core workforce in China, and also were the very populations most affected by enforcement of movement bans and quarantines. In addition, there is no age-group protection from COVID-19, however, the most severe cases were more than 70 years old, with a mortality rates of more than 20% among octogenarians (13, 14). Due to their inaccessibility to mobile software, the participants aged more than 60 years old only accounted for 0.9% of the study.

During the outbreak of COVID-19, in addition to the Wuhan lockdown area, several compulsive measures were implemented to respond to the national emergency. For example, prohibition of public gatherings and entertainment, shutdown of factories and schools, quarantine and isolation, restriction of access to residential areas, all of these changed lifestyles and patterns drastically in every aspect of daily life (15). Travel bans and isolation were the first response to new infectious disease, enforcing thousands of residents who had been exposed to COVID-19 to isolation and self-quarantine. But coercive measures could be counterproductive and erode public trust and cooperation (16). Therefore, it is of great importance to identify the awareness and attitudes of residents who experienced the period of quarantine or isolation. In the present study, participants who were confirmed as healthy after 14 days of quarantine, and those who were not exposed to and not infected by COVID-19, displayed a better response to the survey. The vast majority of participants showed their satisfaction and faith in the measures taken by the authorities during the epidemic. To further explore their attitude toward authorities, we found that those holding a positive attitude also responded better on knowledge regarding COVID-19; while those holding a less positive attitude also practiced worse behaviors or protections, which seemed to account for their faith and support in health authorities in return.

Meanwhile, faced with an overwhelming national pandemic, residents' behaviors toward COVID-19 were of great importance. Scientific behaviors for protection were, therefore, of critical importance, requiring the rapid and appropriate behavioral changes to reduce transmission of disease. In the study, the vast majority of residents had gained insights into the necessity of wearing a mask during the epidemic. It was also demonstrated that surgical face masks could reduce the emission of influenza virus into the environment in terms of respiratory droplets (17), indicating its potential effect for control of COVID-19. In a previous study conducted by Geldsetzer, 37.8% of US participants and 29.7% of UK participants declared that wearing a mask was highly effective to protect themselves from COVID-19-infected (18). However, it was revealed that 98.0% of residents in the Wuhan area would wear a mask when leaving the home during the outbreak of COVID-19 (19). Under the guidance by WHO (20, 21), there are still several suggestions on wearing a mask by public health. Firstly, it is essential to wear a mask in the hospital whether for visiting or for treatment. Secondly, the customers and the staff of public traffic vehicles, such as airplanes, buses and taxis should also wear a mask in daily life. Last but not least, the crowed places without appropriate ventilation, including banks, barbershops, supermarkets, restaurants, are the primary target places to wear a mask when going to these places. In China, however, messaging has advised residents that not wearing a mask is acceptable when staying in a well-ventilated home and in the open air without crowd. This assumption is still controversial around the world and changes of behaviors on its acceptance are worthy of expectations.

This study has at least two main limitations. First, the selection of residents within the nation was randomly selected by network, inducing potential selective bias. Although the survey covered areas with varying levels of COVID-19 incidence and in several provinces, it was not representative of all the nation. Second, the questionnaire used was not a standardized form, composed of single-choice and multiple-choice. To avoid this limitation, the scores were ruled and calculated by an expert panel.

CONCLUSIONS AND POLICY IMPLICATIONS

During the epidemic of COVID-19, we found that participants who were older, married, with middle family income, and who lived with more than two family members, responded well to the survey, and the vast majority of respondents had faith in the measures adopted by the government and supported the measures used by the authorities, which might result from their better awareness and practices. Further research is still needed among a larger sample, such as health professionals, nurses, and confirmed patients. In addition, based on the previous experiences and lessons deriving from China, the following recommendations for daily protection could be proposed in order to prevent and contain the pandemic of COVID-19 in other countries. Specifically:

- Centralized quarantine and household quarantine for suspected cases have been acknowledged as primary and effective measures to curb the epidemic.
- The control measures enacted by authorities are crucial, such as forbidding public gatherings, shutdown of factories and schools, maintaining social distance, and controlling access to communities.
- As a daily effective measure during the epidemic, it is recommended to properly wear a face mask, and that it be properly disposed of after use.

Large scale research is necessary involving healthcare providers, nurses, and affected patients to confirm the

validity of our survey and the protective and preventive suggestions we propose.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/**Supplementary Material**, further inquiries can be directed to the corresponding author/s.

ETHICS STATEMENT

The study was conducted according to the principles of Helsinki declaration. The bioethical committees at Fujian Medical University 2nd Affiliated Hospital, China, gave written approval for the study (2020-206).

AUTHOR CONTRIBUTIONS

YMZ conceived the study. YX, GFL, and CS made the statistics and figures. HFZ and SF designed the questionnaire. XYC, YFC, YXZ, and GAM consulted on the knowledge of COVID-19. XHZ, XJY, and LZ consulted on the figures. All authors interpreted the results, and contributed to writing the article. All authors approved the final version for submission.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpubh.2021.638430/full#supplementary-material

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The Importance of Understanding COVID-19: The Role of Knowledge in Promoting Adherence to Protective Behaviors

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Background: Past research suggests that knowledge supports- but strong illness expectations thwart- adoption of protective behaviors (e.g., handwashing). Strong illness expectations may place COVID-19 essential workers at risk. It is unclear, however, whether knowledge can moderate the negative effects of pessimistic illness expectations on protective behaviors. We test COVID-19 knowledge as a moderator of the effects of (1) pessimistic illness expectations and (2) essential worker status on adherence to protective behaviors.

Methods: Participants ($n = 350$) completed measures of knowledge, illness expectations, and protective behaviors. We used chi-square tests to examine associations between variables and logistic regressions to test the moderation models predicting adherence (low, high) while controlling for demographics.

Results: Knowledge, illness expectations, and adherence were significantly associated with each other ($p < 0.05$). Essential workers had stronger illness expectations and lower knowledge than did non-essential workers ($p < 0.001$). Logistic regressions showed a non-significant Worker Status × Knowledge interaction ($p = 0.59$) but a significant Knowledge × Illness Expectations interaction ($p < 0.05$) indicating that those with strong illness expectations and low knowledge were disproportionately at risk of failing to adhere to recommended behaviors.

Conclusions: Knowledge promotes protective behaviors by buffering the negative effects of pessimistic illness expectations. Essential workers are more likely to have low levels of knowledge with strong illness expectations, suggesting that educational policies may be warranted.

Keywords: COVID-19, protective behavior, prior knowledge, essential workers, pessimistic illness expectations

INTRODUCTION

The COVID-19 pandemic is having devastating effects on human health and well-being and will likely continue to do so through its negative impact on the economy and poverty (1). The magnitude of the crisis can make it difficult to recognize the fact that individuals play an important role in slowing the spread of infection. Protective behaviors, sometimes called non-pharmaceutical

interventions (NPIs), such as social distancing and handwashing, are critical to limiting the spread of infectious diseases (2–4). Essential workers, those who provide critical goods and services during the pandemic, often occupy low-wage positions in public transportation, food production, retail of food and health supplies, and healthcare. Protective of essential workers is particularly important given they are likely to have greater exposure to the virus and are at greater risk of financial strain if they do become infected (5–7).

The Common-Sense Model of Self-Regulation argues that the processes underlying individuals' conceptualization of an illness, referred to as an illness-related memory schema or mental model, include perceptions surrounding the threat posed by the illness and inform potential responses to the threat (8–11). The framework is typically applied to situations in which the patient has experienced a symptom of the illness but is also applicable to self-regulation of prevention-related behaviors during a pandemic. Specifically, illness-related memory schema are based on knowledge and beliefs about the illness and play an important role in the adoption of protective behaviors.

Past research on communicable diseases supports this notion by showing that knowledge and beliefs are important predictors of behaviors that impact the spread of the disease. For example, prior knowledge of a disease has been shown to increase handwashing, which in turn limited the spread of disease (12) and increase willingness to forgo public activities (11). In addition, misunderstandings (i.e., knowledge deficits) about influenza reduced adoption of protective behaviors (13–15). A recent study on COVID-19, on the other hand, reported no effects of knowledge on NPI, which as the authors noted, could be due to overall high knowledge scores (16) Another study, conducted when physical distancing but not mask-wearing was highly recommended (17, 18), found that higher levels of COVID-19 knowledge were associated with attending fewer large gatherings and not wearing a mask when leaving home (19).

In general, the research above suggests that knowledge supports effective health-related decision making. This is consistent with the expression "knowledge is power," which has appeared in cognitive sciences for decades to illustrate the importance of knowledge in human and artificial intelligence (20). Theories, such as the Long-term Working Memory theory (21), propose that the advantages are due to knowledge structures that facilitate comprehension of- and memory for—information that is germane to the knowledge domain (22–24).

In contrast to the beneficial effects of knowledge on NPIs, research indicates that some types of illness-related beliefs can interfere with the adoption of protective behaviors. Specifically, a high level of certainty that one will become infected is associated with lower adherence to health-protective behaviors (25–28). Strong illness expectations may represent the belief that fate, rather than the individual, controls whether the individual contracts the illness, making protective behaviors relatively unimportant (25, 26). This is consistent with the notion that pessimistic, or *why bother*, beliefs increase avoidance behaviors (11, 29–31). On the other hand beliefs, such as perceived vulnerability, are positively associated with protective behaviors,

which presumably help to reduce discomfort associated with feeling vulnerable (32, 33).

We are not aware of any studies on protective behaviors that have assessed both knowledge and beliefs as well as the relationship between knowledge and beliefs. However, a recent study that took place prior to an outbreak of COVID-19 in Australia included both knowledge and beliefs as predictors of NPI and vaccine intentions (34). Results showed that beliefs, including self-protection efficacy and perceived vulnerability, were positively associated with NPI but neither predicted vaccination intentions. Knowledge (symptoms, transmission, and general knowledge) was negatively associated with NPI but positively associated with vaccination intentions (34). Given the timing of the study, it could be that knowledgeable individuals understood that the threat had not yet reached a critical level so NPIs were not prioritized. Another challenge with interpreting the knowledge findings is many of the items were in areas that were rapidly evolving, making it difficult to know whether an individual knew more or less than what had been released to the public at that time (34). In another recent COVID-19 study, researchers showed that providing expert information about coronavirus infectiousness reduced fatalistic beliefs (35). Although NPIs were not assessed in that study, the findings suggest that providing knowledge can reduce maladaptive beliefs. Thus, despite theoretical work supporting the notion that mental models of one's illness, comprised of knowledge and beliefs, play an important role in health behaviors (8–11), there is little direct evidence regarding the extent to which knowledge mitigates the negative effects of illness expectations on the adoption of protective behaviors.

In the present study, we examined the extent to which COVID-19 knowledge and illness expectations predicted adherence to protective behaviors (handwashing, wearing a mask, avoiding crowded areas, 6-foot distance between individuals). We anticipated that knowledge would be positively associated with—but that illness expectations would be negatively associated with—protective-behavior adherence. The current pandemic differs from many past outbreaks in the US in that most individuals were ordered to stay-at-home at the time this study took place (18), while essential workers were not, providing an opportunity to compare knowledge and beliefs of essential and non-essential workers. We expected that essential workers may have stronger illness expectations than non-essential workers. It is unclear, however, whether knowledge would differ between essential and non-essential workers. Finally, the extent to which knowledge protects against disruptive beliefs, knowledge would be expected to moderate the relationship between beliefs and adherence to protective behaviors, and possibly, between essential-worker status and protective behaviors.

METHODS

Participants

Participants ($n = 350$) from across the United States were recruited through Amazon Mechanical Turk (MTurk) during the 2nd week of April 2020. Stay-at-home mandates were in

place for the majority of states at that time (six states had recommendations only, one state had neither a mandate nor recommendation) (18). MTurk is a crowdsourcing platform that is appearing with increasing frequency in behavioral and medical research (36, 37). This method allows individuals to participate from home at any time of day, which may have been particularly advantageous during the pandemic. The study was approved by the university's IRB.

Measures

To assess knowledge related to COVID-19, we created 15 True/False questions from public-facing information provided on Johns Hopkins Medicine website on basic definitions and common myths about COVID-19. We developed this measure because no knowledge tests existed at the time of the study. We included items that assessed general information about the virus relative to other infectious diseases, virus transmission, and prevention (38). Items and correct answers are presented in **Table 1**. With one exception (*There is no vaccine to protect against the virus*), answers to the knowledge questions did not change between the time the study took place and the publication of this paper. A vaccine was developed roughly 7 months following the study. The total number of correct responses was used in the logistic regression analyses; however, for consistency with other predictors, a categorical variable (based on a median split) was used to examine unadjusted relationships. Pessimistic illness expectations were assessed using two items: *To what extent do you expect to become – infected with COVID-19/– very sick if infected* on a scale of 1 (Definitely will not) to 5 (Definitely will) (39). Because we were interested in pessimistic illness expectations, we considered high scores (ratings of 4 or 5) on either or both items to indicate strong illness expectations and low scores (ratings

of 1–3, which included neutral expectations) on both items to indicate weak expectations.

Protective behaviors were assessed by asking participants how frequently they followed 9 recommendations put forth by CDC (e.g., washing hands, social distancing) on a scale of 1 (Not Often) to 4 (Always) to reduce their risk of getting or spreading COVID-19 (2). *Adoption* to a protective behavior was considered *Yes* for scores of "often" or "always" with high adherence defined as the adoption of all nine behaviors. The items, shown in **Table 2**, created a reliable assessment of overall protective behaviors as reflected in a Cronbach's alpha coefficient of 0.80. To assess essential worker status, we asked individuals to indicate whether they were an essential worker, non-essential worker, or not working. Finally, we asked participants whether they had tested positive for COVID-19 as a covariate.

TABLE 2 | Adherence to protective behaviors.

	Count	%
Washing hands and/or using sanitizers frequently	283	83.0
Staying at least 6 feet away from others	288	84.5
Avoiding large gatherings	299	87.7
Not going out to restaurants or bars	277	81.2
Wearing a face mask when outside the home	212	62.2
Not shaking hands or touching people	288	84.5
Wiping down surfaces with disinfectant	231	67.7
Staying at home (except for buying food, etc)	289	84.8
Limiting contact with others	290	85.0

TABLE 1 | Knowledge items by response type percentage and correct responses shown in bold.

	True	False	Not sure
The virus is a severe form of the flu	43.4	**44.3**	12.3
Pets can spread the virus to humans	29.0	**48.4**	22.6
The virus spreads more quickly than most others including SARS	**78.9**	11.1	10.0
The virus is a mutated form of the common cold	27.3	**55.4**	17.3
Social distancing is key to reducing the spread of the virus	**83.6**	12.9	3.5
Individuals without symptoms can spread the virus	**79.5**	16.1	4.4
The virus can spread through insect bites	16.7	**69.8**	13.5
There is no vaccine to protect against the virus[*]	**83.0**	12.9	4.1
The primary, overarching goal of requiring people to shelter in place is to decrease the rate of transmitting the virus	**60.1**	39.9	NA
There are different kinds of coronaviruses, all of which can cause serious illness in humans.	70.1	**18.5**	11.4
The coronaviruses are named for their smooth surface as seen under a microscope.	24.0	**52.5**	23.5
Health officials do not believe COVID-19 was deliberately created or released by people.	**58.7**	20.2	21.1
The virus can cause severe respiratory problems impacting the nose, throat, and lungs.	**91.2**	5.9	2.9
The incubation period of COVID-19 is within 14 days of initial symptoms.	88.3	**6.2**	5.6
At this time, the number of people who have died from COVID-19 worldwide is far lower than the number of people who have recovered.	**66.6**	16.4	17.0

A vaccine had not yet been developed in April, 2020, when the survey was administered; NA, not applicable because this item had only True/False options.

Analytic Strategy

Unadjusted associations among essential worker status (yes/no), knowledge (low, high), illness expectations (weak/strong pessimism), and protective behavior adherence (low, high) were examined using Chi-square and Spearman's rho. We conducted logistic regressions to test two moderation models on adherence after controlling for age, sex, race, ethnicity, education, and income. The first model tested illness expectations as a possible moderator of the effects of knowledge on prevention behaviors and the second model tested worker status as a possible moderator. In both models, knowledge scores (i.e., total number of questions correctly answered) were mean-centered prior to creating the interaction term.

RESULTS

Of those enrolled in the study ($n = 350$), 9 failed to pass the attention check and were excluded from analyses. As shown in **Table 3**, the final sample ($n = 341$) was 40.2% female, 78.6% Caucasian, and generally well-educated with 62.5% having 2 or more years of college. Close to one-third of the sample (36.7%) were essential workers; only six participants indicated they were not working and these individuals were included in the non-essential worker group. Essential workers were more likely to be Hispanic ($p < 0.001$), but did not differ in terms of age ($\chi^2_1 < 1$), sex ($\chi^2_1 = 1.30$, $p = 0.28$), race ($\chi^2_1 = 5.01$, $p = 0.08$), education level ($\chi^2_1 = 1.62$, $p = 0.20$), or income ($\chi^2_1 < 1$). The null finding for income is contrary to the suggestion that non-essential workers earn less than other workers (5), and could be due to the relatively well-educated individuals who tend to participate in research through online panels.

Overall, adherence to protective behaviors was high as indicated by adherence rate of 80% across the nine NPI behaviors. Close to two-thirds of the sample (63%) reported adherence to eight or fewer behaviors. The distribution was highly skewed to the left (skewness $= -1.45$), leading us to dichotomize the distribution into partial adherence (low) and complete (high) adherence, which represented the top third of the distribution with adherence to all nine behaviors (40). As shown in **Table 2**, the behavior with the lowest adherence was wearing a face mask when outside the home (62%) and the behavior with the highest adherence was avoiding large gatherings (87%).

Unadjusted Associations

Essential worker status was associated with lower knowledge and more pessimistic illness expectations ($p < 0.001$ for both). Higher knowledge was associated with less pessimistic illness expectations ($p = 0.02$). Adherence was associated with higher knowledge ($p = 0.04$), non-essential worker status ($p < 0.01$), and less pessimistic illness expectations ($p < 0.01$). Although not a key variable, it is interesting to note that only 14 participants (4.1%) indicated that they had tested positive for COVID-19; all of these individuals were essential workers and 13 (92.8%) were in the low-adherence group.

TABLE 3 | Participant characteristics ($n = 341$).

Variable	Description	N	%
Age (years)	20–35	174	51.0
	35–73	167	49.0
Sex	Male	204	59.8
	Female	137	40.2
Education	<2 years of college	128	37.5
	≥2 years of college	213	62.5
Race	Caucasian	268	78.6
	Non-caucasian	73	21.4
Ethnicity	Hispanic	42	12.3
	Non-hispanic	299	87.7
Income	<$50,000	140	41.1
	≥$50,000	201	58.9
Essential worker	No	209	61.3
	Yes	132	38.7
Pessimistic illness expectations	Weak	206	60.4
	Strong	135	39.6
Adherence to protective behaviors	Low	216	63.3
	High	125	36.7
	Range	**Mean (SD)**	
Knowledge (0–15)	3–15	9.15 (2.44)	

Logistic Regressions

We tested the fit of two moderation models using logistic regressions. For both models, demographic variables (age, sex, race, ethnicity, education, and income) were added in block 1, main effects of key variables (essential worker status, illness expectations, and knowledge) and virus test results were added in block 2, and the interaction effect Knowledge x Illness Expectations (Model 1) or Knowledge x Worker Status (Model 2) was entered in block 3 (see **Table 4**).

Data from Block 2 reflect the effects of predictors after controlling for demographic variables. Results showed Essential Worker Status was negatively associated with adherence (OR 0.58, 95% CI 0.34–0.97, $p = 0.04$) but the effects of illness expectations (OR 0.62, 95% CI 0.37–1.03, $p = 0.06$) and knowledge ($p = 0.24$) were not significant. Because the zero-order associations were significant, the non-significant effects are likely due to variance shared with the variables entered in blocks 1 and 2. Block 3 differed for each model. In Model 1, the Knowledge × Illness Expectations interaction was significant ($p = 0.02$). **Figure 1** shows the predicted values from the model indicating that the negative association between pessimistic illness expectations and adherence was evident for those with lower levels of knowledge only. The Essential Worker Status × Knowledge interaction was not significant ($p = 0.59$), indicating that knowledge moderates the effects of illness expectations, but not essential worker status *per se*.

TABLE 4 | Tests of model effects predicting adherence to protective behaviors (significant effects shown in bold).

	Variable (reference group)	B	S.E.	Sig.	Exp(B)	95% C.I. for EXP(B)	
						Lower	Upper
Block 1	Age (20–35)	−0.45	0.24	0.06	0.64	0.40	1.03
	Sex (male)	0.36	0.24	0.14	1.43	0.90	2.29
	Education (<2 years college)	0.24	0.25	0.33	1.28	0.78	2.09
	Hispanic (non-hispanic)	−0.28	0.38	0.46	0.76	0.36	1.59
	Race (Caucasian)	0.09	0.29	0.75	1.10	0.63	1.92
	Income (<$50,000)	**0.59**	**0.25**	**0.02**	**1.81**	**1.10**	**2.97**
Block 2	Essential worker status (no)	**−0.55**	**0.27**	**0.04**	**0.57**	**0.34**	**0.97**
	Pessimistic illness expectations (weak)	−0.48	0.26	0.06	0.62	0.37	1.03
	Knowledge	0.06	0.05	0.24	1.06	0.96	1.17
	Tested positive for covid-19 (no)	−1.64	1.10	0.14	0.19	0.02	1.67
Model 1 - Block 3	Knowledge by illness expectations	**0.26**	**0.11**	**0.02**	**1.29**	**1.04**	**1.60**
Model 2 - Block 3	Knowledge by worker status	−0.58	0.11	0.59	0.94	0.76	1.16

Total Nagelkerke R^2 Model 1 = 0.14; Model 2 = 0.12 (R^2 Block 1 = 0.05, R^2 Block 2 = 0.12).

FIGURE 1 | Moderating effects of knowledge on the relationship between pessimistic illness expectations and adherence to protective behaviors. Note, knowledge scores were entered as a continuous variable in regression analyses but are shown here as a dichotomous variable (median split) for illustration purposes.
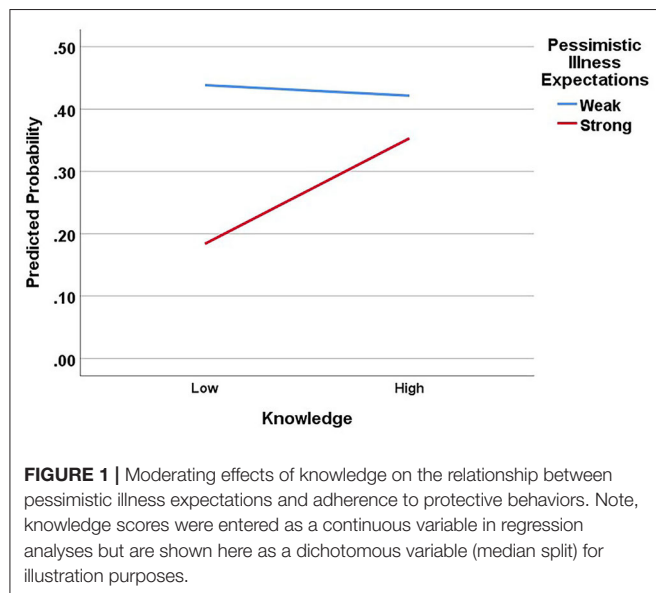
DISCUSSION

Findings from the present study are consistent with past research on NPIs indicating that knowledge is positively—and pessimistic illness expectations are negatively—associated with protective behaviors (12–14, 25, 26). We add to the literature by showing that knowledge and illness expectations are negatively associated with each other and suggest that the two predictors have opposing effects on adherence to protective behaviors. We further specify the nature of the relationships by showing that knowledge moderates the effects of illness expectations on adherence such that the negative effects of high levels of illness expectations as mitigated by high levels of knowledge.

We cannot determine from this cross-sectional study whether illness expectations lead to adherence failure or knowledge leads to adherence success. Nor can we determine how knowledge impacts the relationship between illness expectations and adherence. Although it seems plausible that understanding the virus tempers the certainty that one will become infected if some precautions are taken, additional research is needed to examine causal links.

The findings are consistent with the Common-Sense Model of Self-Regulation arguing that knowledge and beliefs play a critical role in illness representations (or schema), which in turn drive behavior (9). Illness expectations that are constructed from knowledge about the virus, how it is transmitted, and what limits transmission may protect against potentially harmful beliefs based on misunderstandings and mistrust of credible sources. For example, understanding that a rapid rate of transmission could overwhelm the healthcare system and in turn limit care for everyone, not just those with COVID-19, may prevent individuals from believing that personal choice should dictate adherence to protective behaviors (41). Thus, knowledge-based illness representations may serve as a comprehensive navigation tool for making effective health-related decisions during the pandemic (38).

An important question to consider in future research is how rapidly changing scientific knowledge of an infectious disease impacts the acquisition of laypersons' knowledge of effective NPIs. With many unknowns about the novel coronavirus, particularly at the start of the pandemic, scientific evidence and therefore NPI recommendations were in flux. For example, recommendations to use face covering, broadly defined, appeared at the end of March, 2020; whereas the more precise recommendation to use of multi-layer cloth masks appeared in November, 2020 (17). State and county mandates surrounding masks and other NPIs have also shifted over time, potentially affecting acceptance of NPIs among the public, and subsequently,

COVID-19 growth rates (42). The flow of information between public health officials and the public is also influenced by social media, which includes information that extends beyond geo-political boundaries (43, 44).

Still, even under stay-at-home orders, individuals have many opportunities to be around others inside and outside the home (e.g., visit others, grocery store) requiring the use of protective behaviors. The abundance of misinformation that occurred during COVID-19 has made the question of protection against incorrect information more salient. Future research is needed to examine the extent to which science literacy could serve as a buffer against misinformation that threatens the public's health and well-being.

The rapid spread of COVID-19 in the spring of 2020 likely increased fear and confusion surrounding safety and may have decreased the opportunity to acquire factual information about the virus, for example, its incubation period and transmission process. Layered on top of this, the coronavirus has a relatively wide window of time, potentially 2 weeks, in which those who are infected with COVID-19 can transmit the virus without being aware that they are infectious (45). Thus, targeted strategies to increase individuals' understanding of COVID-19 may be a necessary component of an organization's safety plan as well as public health outreach more generally.

The data showing that (1) essential workers had strong illness expectations and low levels of knowledge and (2) both patterns predicted reduced adherence to protective behaviors suggest an additional layer of vulnerability. When essential workers—and those they serve—fail to adhere to protective behaviors, risk increases for all. It is unclear what should be done when essential workers or the public fail to adhere to orders requiring protective behaviors. However, an equally important question may be how do we promote learning about COVID-19 and other infectious diseases as a way to prevent adherence failures. Research is needed to examine the extent to which knowledge reduces the impact of maladaptive beliefs on NPIs as well as pharmaceutical interventions such as vaccinations, which are being avoided by a growing number of individuals (46, 47).

Limitations

Limitations of this study include the use of crowdsourcing panel that is predominantly white and relatively well-educated and the majority of participants had some college education. Given that education would be expected to increase adherence, the findings may provide a more optimistic view of adherence than is warranted. However, the lack of ethnic and racial diversity limits the generalizability of the findings. Additionally, the study assessed knowledge, illness expectations, and protective behaviors at only one point in time and it could be that these factors change as the crisis evolves. Another limitation

is that the study did not differentiate among types of essential workers, such as healthcare or food service, or consider official designations of essential worker categories at the time of data collection. It seems likely, for example, that healthcare workers who interacted with a volume of patients could have greater illness expectations or higher knowledge than other essential workers. Finally, it is important to recognize that the sample size of the study was small relative to epidemiological studies and was not representative of the population. The study was intended to provide an exploration of the dynamics between knowledge and beliefs within a context of a growing pandemic to consider how these factors could potentially impact NPIs. Replication with a larger, representative sample is needed to build on these findings, further specify mechanisms underlying adherence to protective behaviors, and inform the development of interventions that seek to empower individuals through increased knowledge and decrease pessimistic illness expectations.

CONCLUSIONS

This study indicates that pessimistic illness expectations increase the risk of failing to adhere to protective behaviors but that knowledge protects against the negative effects of these expectations. The findings have implications for practice and policy, particularly related to essential workers and their environment. Additional work is needed to identify optimal approaches to increasing individuals' knowledge to the point where it reduces or eliminates maladaptive beliefs. By helping to specify the predictors associated with protective behaviors during the pandemic, this line of inquiry may help to fill important gaps in our understanding of how to help slow the transmission of COVID-19 from individual to individual.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by IRB University of California, Davis. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

LM conceptualized the study and collected and analyzed the data. All authors contributed to drafting and revising the manuscript.

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The remaining author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Medical Students' Voluntary Service During the COVID-19 Pandemic in Poland

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From the very first moment coronavirus struck, medical students volunteered to support healthcare professionals' fight against the COVID-19 pandemic. To learn more about future healthcare professionals' volunteering during such an outbreak, we conducted a survey among 417 students of Poznan University of Medical Sciences. Our findings suggest that although numerous studies demonstrate that traditional, value-based volunteering is decreasing, and especially higher education students are more oriented toward their own career, in the times of the current health crisis, young peoples' involvement in volunteering has been mainly driven by altruism and the ethical imperative to serve their community, their fellow healthcare professionals and their patients. Thus, while the prime role of the volunteering was to relieve the healthcare system, it also reinforced such important medical values as altruism, public service and professional solidarity. Moreover, it proved that whilst risk is inherent to medicine, the students' volunteering is truly a moral enterprise.

Keywords: COVID-19, pandemic (COVID-19), students, voluntary service, future healthcare professionals

INTRODUCTION

Ever since the first case of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection in Poland was confirmed on 4 March 2020, the Polish government has imposed different types of lockdown-type control measures, including the closing of universities, which moved to online lectures, and on 20 March a state of epidemic was announced. However, although medical students were pulled off from the hospital's medical universities in the country, many universities started encouraging future healthcare professionals to volunteer. Consequently, although they faced concerns about their health and education, thousands of Polish students from the faculties of Medicine, Pharmacy and Health Sciences have supported the fight against the coronavirus pandemic and engaged in voluntary service in local hospitals, sanitary-epidemiological stations, emergency units, hospital pharmacies, the university's diagnostic laboratory and local call centers, and soon most places were filled by volunteers and many other students are still waiting for their turn.

This is of key importance, because in many countries, i.e., Italy or Spain, the healthcare systems reached a breaking point and have been seriously burdened by the COVID-19 pandemic and the struggle with insufficient medical personnel. Moreover, while the media has publish many distressing images of ill and dead people in various European countries, Poland has difficulty in retaining its health professionals and has the lowest number of physicians per 100,000 inhabitants in the European Union, and the number of practicing nurses in the country is also one of the lowest in the EU (1).

TABLE 1 | Socio-demographic characteristics of students.

Characteristics	N (%)
Gender	
Female	301 (72.2)
Male	116 (27.8)
Year of study	
1	40 (9.6)
2	87 (20.9)
3	56 (13.4)
4	99 (23.7)
5	74 (17.7)
6	61 (14.6)
Faculty	
Medicine	256 (61.4)
Nursing	42 (10.1)
Pharmacy	23 (5.5)
Electroradiology	20 (4.8)
Medical analytics	19 (4.5)
Dentistry	14 (3.4)
Midwifery	11 (2.6)
Medical rescue	10 (2.4)
Other	22 (5.3)
How many times have you volunteered before?	
0	117 (28.1)
1	26 (6.2)
2	62 (14.9)
3–5	106 (25.4)
6–10	34 (8.1)
>10	72 (17.3)

TABLE 2 | Students' experience of a pandemic.

	N (%)
What were your feelings after hearing about the coronavirus outbreak?	
Fear for loved ones	273 (65.5)
Willingness to act	249 (59.7)
Fear about my own future	116 (27.6)
Anger	153 (36.7)
Nothing, it was irrelevant to me	24 (5.8)
Other	28 (6.7)
What were your feelings after hearing about the control measures ruled by the government?	
That the government's reaction was right	363 (87)
That the government is overreacting	45 (10.8)
It was irrelevant to me	9 (2.2)
Did you consult your decision on engaging into voluntary service with anybody?	
Parents	247 (59.2)
Siblings	61 (14.6)
Partner	175 (42)
My fellow students	214 (51.3)
My university teacher	18 (4.3)
A priest	3 (0.7)
No	72 (17.2)

Moreover, while until October 14, 141 804 cases of infections were reported in Poland, 3 217 patients died and 83 847 recovered (2), it is healthcare professionals that are at the increased risk of being infected as 17% of those infected are health professionals; near 4,000 medics were infected (including 986 physicians, 2 393 nurses, 212 midwifes, 89 dentists, 75 laboratory diagnosticians, 68 paramedics and 64 pharmacists), 31 077 were quarantined (8 881 physicians, 18 495 nurses, 1 644 midwifes, 824 dentists, 674 pharmacists, 451 laboratory diagnosticians and 108 paramedics), 678 were hospitalized (398 nurses, 194 physicians, 31 paramedics, 27 midwifes, 12 dentists, eight pharmacists and five laboratory diagnosticians) and 13 have died (seven physicians, six nurses) (3). Thus, although some countries asked medical students to step down, this is not the first time when future health professionals serve at the frontline of the battle with the pandemic (4, 5). Not surprisingly, medical, nursing, midwifery, physiotherapy and pharmacy students have adapted to many new roles and help in administrative and office work, in emergency rooms and hospital wards, interview patients, care for outpatients through telemedicine, translate English texts about COVID-19, help with making supplies of personal protective equipment, sew protective masks or provide child care for healthcare workers.

At the same time, while some theories concerning volunteering focus on personal motives and emphasize rational action and a cost-benefit analysis, others stress the role of accessible social resources such as organizational activity and social ties (6, 7). However, researchers have also investigated the contextual effects on volunteering and have paid attention to the impact of organizational, community and regional characteristics on individual decisions to volunteer (8, 9). Moreover, it is often argued that volunteerism has much in common with social activism and that both types of collective engagement are not so much initiated by the state or by political professionals but by collectives who act together for a common and specific purpose (10, 11). Indeed, in response to the crisis situation caused by the COVID-19 outbreak, Poznan University of Medical Sciences (PUMS), in collaboration with university's student organizations, initiated a COVID-19 student volunteering project. And while students who joined the project were offered various compensations, including credits for a compulsory internship or flexible assessment of e-learning outcomes, the project itself emphasized that nurturance and care for others were deeply embedded in the role of health professionals. Nevertheless, many scholars argue that the nature of volunteering is being restructured and that volunteers' motivations are changing as the old or traditional forms of volunteering (long-term, based on membership, inspired by

TABLE 3 | Students' experience with voluntary service during the COVID-19 pandemic.

	N (%)
What do you do during voluntary service?	
I help in administrative and office work	166 (39.8)
I help with the documentation of patients and persons under epidemiological surveillance	49 (11.8)
I give telephone advice in a sanitary-epidemiological station	29 (7)
I take medical history from those infected	89 (21.3)
I give medical advice on the Internet and at a telephone information desk	20 (4.8)
I help in the emergency room	139 (33.3)
I help with medical procedures in a hospital ward	75 (18)
I help in the university's diagnostic laboratory	24 (5.8)
I sew protective masks	14 (3.4)
I help with making supplies of personal protective equipment	35 (8.4)
I help those in need, i.e., the seniors, the children	21 (5)
I help with the translation of English texts about COVID-19	16 (3.8)
Were you anxious about anything during your voluntary service?	
That I can get infected	131 (31.4)
That the healthcare system may collapse	132 (31.7)
That the pandemic will affect my studies	198 (47.5)
That pandemic will affect the situation in the country	199 (47.7)
That I will not handle it	69 (16.5)
That the pandemic will affect my economic situation	114 (27.3)
I had no worries	60 (14.4)
What was people's, including your colleagues', reaction to your voluntary service?	
Positive	365 (87.5)
Indifferent	31 (7.5)
Negative	21 (5)
Does voluntary service meet your expectations?	
Yes	329 (78.9)
No	88 (21.1)
Do you regret your decision to join the voluntary service?	
Yes	15 (3.6)
No	402 (96.4)
Do you find voluntary service harder than you expected?	
Yes	61 (14.6)
No	356 (85.4)

TABLE 4 | Reasons of students' involvement in voluntary service during the COVID-19 pandemic.

What was the main reason to engage in voluntary service during the COVID-19 pandemic	N (%)
To put my voluntary participation into my future application documents	8 (1.9)
To gain experience needed in my future profession	53 (12.7)
To establish new connections that will be useful in the future	2 (0.5)
I believe it is important to help others	87 (20.9)
I believe that the role of medics is to engage and help whatever the risk	98 (23.5)
It gives me the opportunity to pay back for all I have received myself	5 (1.2)
I wanted to be a part of something important	54 (12.9)
To experience the adventure	9 (2.1)
It gives me the opportunity to realize my passion	11 (2.6)
It is better than sitting at home and studying, or to be bored	41 (9.8)
To meet new people, make new connections and friends	4 (1)
I was advised by my teacher/parent that I may benefit from it	4 (1)
I was encouraged by a friend who also volunteered	5 (1.2)
Completion of work placement	22 (5.3)
Other	14 (3.4)

MATERIALS AND METHODS

The study was conducted between 5 of May and 30 of June 2020. Participants were students enrolled in different faculties of Poznan University of Medical Sciences, Poland. An online questionnaire which was posted on an online platform was used. The process of elaborating the questionnaire followed the guidelines of the European Statistical System (19). The questionnaire consisted of four main sections: students' experience of the pandemic, students' experience with voluntary service during the COVID-19 outbreak, the reasons students' became involved in voluntary service, and socio-demographics. It was reviewed by a panel of experts and revised based on their comments. The final version of the questionnaire was approved by the University Student Council Board (USCB). All the participants received an invitation letter and informed consent was obtained from all individuals included in the study. The results are presented as descriptive statistics.

RESULTS

From the beginning of the pandemic, PUMS received applications from students who wished to support hospitals and other units of the healthcare system with their work. By the end of May, 741 of them had started volunteering. They were directed to help both university units and those under the control of the local authorities. Of this group, 417 students (56.3%) completed the questionnaire. Our group consisted of 301 females and 116 males (**Table 1**), representing all degree courses and years of study, but most of them, 256 (61.4%), were students of the medical faculty, which is the most numerous. The majority of

altruistic values and the importance of social interactions and connected to religious or political communities) are being replaced by the modern type of volunteering (project-oriented, based on career development and personal growth and not rooted in a local community) (12–16).

Thus, while some studies have described the knowledge and attitudes toward the COVID-19 among medical students (17, 18), this study focuses on students' experience of the pandemic and describes their experience with voluntary service during the COVID-19 pandemic. It also analyses the reasons behind the future healthcare professionals' involvement in voluntary service during the COVID-19 outbreak in Poland.

TABLE 5 | Students' motivations.

	1	2	3	4	5	Mean
To enhance my professional résumé	180	85	80	55	17	2.15
To get new knowledge and skills	34	41	90	109	143	3.69
To gain professional experience	40	48	79	130	120	3.58
To make new contacts that might help me in the future	76	98	115	96	32	2.78
To help others	8	12	39	113	245	4.38
To give something from myself to the community	15	26	57	125	194	4.1
To realize the duty of public service inherent to the medical profession	60	51	78	96	132	3.45
To help succeed in the fight against the pandemic	34	41	82	145	115	3.64
To participate in something important	39	40	85	115	138	3.66
To have a sense of duty and pride	48	61	76	120	112	3.45
To realize my passion	36	38	105	124	114	3.58
To experience the adventure and to tell my future kids that I was a part of it	110	85	89	83	50	2.71
To fill free time	106	63	85	97	66	2.89
To make new friends and establish new connections	103	99	108	72	35	2.61
To work with other people	39	61	92	126	99	3.44
To gain the recognition of my professors, family and friends	196	113	64	37	7	1.91

volunteers 300 (71.9%) had various types of volunteer experience before the pandemic, and 72 (17.3%) had been volunteers more than 10 times.

The main feelings evoked by the coronavirus outbreak in our respondents were fear over their loved ones (65.5%) and the willingness to act (59.7%) (**Table 2**). Simultaneously, the vast majority of students (87%) believed that the control measures imposed by the authorities were justified. Before deciding to participate in volunteering, 59.2% of students consulted their parents and 51.3% their university friends.

The largest group of students participated in administrative work (39.8%), helped in emergency rooms (33.3%), took the medical history of the patients (21.3%) and helped with medical procedures in a hospital ward (18%) (**Table 3**). Others helped with making supplies of personal protective equipment and gave telephone advice in a sanitary-epidemiological station (7%). At the same time, most volunteers were not so much concerned over the possibility of being infected (31.4%) as they were about how the pandemic might affect the situation in the country (47.7%) and their studies (47.5%). Additionally, almost one third of students were afraid that due to the pandemic the healthcare system might be seriously burdened or even collapse (31.7%) and that the pandemic might affect their economic situation (27.3%). Interestingly, while 16.5% of students worried that they may not handle the voluntary service, 14.4% had no worries.

More than 87% of volunteers declared having met with positive reactions either form their families, fellow colleagues or friends. Moreover, while the majority declared that the voluntary service met their expectations (78.9%), very few regretted their decision to join the COVID-19 student volunteering project (3.6%). And although some students admitted being concerned over their qualifications which might be inadequate to their responsibilities, over 85% of students declared that voluntary service was not as hard as than they had expected.

For 23.5% of the students the most important reason to engage in voluntary service during the pandemic was their belief that the role of medics is to engage and help regardless of the risk, while 20.9% believed that it is important to help others, 12.9% wanted to be a part of something important and 12.7% wanted to gain experience needed in their future profession (**Table 4**).

Volunteers were also asked to rate on a scale from 1 (not significant) to 5 (very important) various reasons for volunteering (**Table 5**). Fifty eight point eight percentge of the students gave the highest rating to the option "help others," and 46.5% chose "giving something from myself to the community." On the other hand, 4.1% wanted to enhance their professional résumé.

DISCUSSION

Despite the closure of all medical universities in Poland, hundreds of future healthcare professionals volunteered in their communities and local hospitals to provide medical assistance and guidance to the public. Although students were aware that they were not full-fledged members of the medical teams, that their ability to provide care was limited and that their primary role was to learn medicine, most volunteers believed that it is their duty to serve society, help medical professionals and care for patients. Moreover, even though respondents felt anxious about the social, economic and health disruptions caused by the virus, their future and of the possibility of being infected, they eagerly made a commitment and took the Hippocratic Oath to care for those in need very seriously.

Thus, while some research suggests that among higher education students a new type of the so called résumé building volunteering becomes more popular (12–14), our study shows that in the times of the health crisis caused by the COVID-19 outbreak, young peoples' involvement in voluntary service is mainly driven by altruism and public service, and can be

described as traditional, value-based volunteering. Even though some students stepped up for more individualistic and career reasons, i.e., they hoped that their voluntary service will help them to gain new knowledge and skills, develop their personal career or allow them to pass their summer internships, many others did so to fulfill the calling that the healthcare profession entails. This supports the observation made by Gage and Thapa (15) who argue that students' volunteerism is mostly driven by their desire to help others and expand their character. Thus, it seems that while for many students résumé building and gaining new knowledge and skills was somehow important, it was rather an additional benefit and not a prime motivation (16). On the contrary, as most students were more driven by the ethical imperative to serve their community, healthcare professionals and their patients, they stepped forward out of a sense of civic responsibility, believed that the healthcare service is a unique vocation and that as future health professionals it was their duty to engage and help, whatever the risk (4, 5).

CONCLUSION

While the prime role of students' voluntary service during the COVID-19 pandemic was to relieve the healthcare system before it reaches a personnel crisis similar to that in other countries, it also helped students to learn new practical skills, rethink ethical dilemmas learnt during their courses and, most importantly, reinforced such important values of medical ethos as: altruism, public service and (professional) solidarity. Moreover, by undertaking a variety of tasks, from administrative and office work, giving telephone advices in call centers, helping in hospital wards and university's diagnostic laboratories to the translating of English texts about COVID-19 and sewing protective masks, students have proved that although risk to life is inherent to the healthcare service, medicine is truly a moral enterprise. Finally, this study shows that student's voluntary service during the coronavirus pandemic is an important part of service learning (20) which should become an integral component of medical education.

Strengths and Limitations

Of course, our study does have its limitations. First, as we analyzed responses from students from only one medical university in the country, the study has a local dimension. Consequently, it would be desirable to compare the findings from other medical universities. However, to the best of our knowledge, no research on students' volunteering during the COVID-19 pandemics at other Polish universities has been done. Moreover, we believe that because this is a pilot study, it may stimulate further research on students' voluntary work during the COVID-19 pandemic. Second, although the response rate was moderately high, the results represent only the opinions of students who agreed to participate in the study and cannot be generalized for the entire student population either in Poznan or in Poland. Third, non-random sampling is another limitation as it prevented an analysis of the socio-demographic, structural and socio-cultural background of the issues discussed in our research. Finally, as this study is based on the quantitative method only, to understand better students' motivations, opinions and lived experiences, further in-depth studies using qualitative methods would be required. Nevertheless, we believe that as this is the first study on students' voluntary service during a coronavirus pandemic in Poland, it may stimulate further research on the topic.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

JD designed the study, collected the data, and wrote the original draft of the manuscript. DW performed the statistical analyses. JD and DW conducted the literature search and analyses, discussed the results and interpreted the data. JD and DW edited and approved the final version of the manuscript.

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India's COVID-19 Burdens, 2020

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The purpose of this article is two pronged; first, to identify and report public health implications of the ongoing coronavirus (COVID-19) pandemic, and second, to report challenges uniquely faced by the citizens of India from a population health perspective. We have done both while closely examining epidemiological data that is accessible via SMAART's RAPID Tracker. This policy informatics platform is a live database aimed to track the geospatial spread of the COVID-19 outbreak and policy actions globally and is administered collaboratively by CUNY's Graduate School of Public Health and Health Policy and a global, non-profit public health incubator. Infectivity, incidence, and recovery rates were computed and graphical representations of epidemiological datasets were studied. We have discussed a plausible conceptual framework based on the principles of population health informatics for countries with similar characteristics to build a stronger public and community health foundation in order to safeguard populations during a health emergency in the future.

Keywords: COVID-19, India, SMAART RAPID tracker, public health, public policy

INTRODUCTION

We are in the middle of the first global pandemic of the 21st century and as of December 17, 2020, 72,556,942 COVID-19 cases and 1,637,155 deaths due to COVID-19 were reported worldwide (1, 2). The novel coronavirus that causes COVID-19 was identified in Wuhan, China, in December 2019 (3). By January 30, 2020, the World Health Organization (WHO) declared a global health emergency due to the virus' rapid spread around the world (3). **Figure 1** indicates a global spatiotemporal trend of COVID-19 since January 21, 2020 indicating the four countries with the highest caseload—the United States of America, India, Brazil, and the Russian Federation. The dotted lines are observed datasets, and exponential growth trends can be observed for all components of **Figure 1**, keeping in mind that outbreak statistics behave differently for national and worldwide levels. Looking closely at country-wise incidence, it is indicated that India's total pandemic caseload as of December 17, 2020 was at 9,956,557 making it the second-highest in the world and exceeding that of Brazil as of September 7, 2020. When comparing the spatial and temporal trends of India to the rest of the world in **Figure 1**, the blazing question arises that even though India is China's immediate over populated neighbor, why was this novel disease late in establishing a foothold in India? We will touch upon this epidemiologic concern in the Discussion section. The data also makes us ponder whether India will surpass the United States of America in recrudescence as it surpassed the Russian Federation on July 6, 2020 with 22,252 new cases as well as with Brazil on September 7, 2020 with 90,802 cases (1). What dynamic roles do India's socio cultural characteristics play in making this a delayed hotspot? How is India prepared to face the burdens of this expanding pandemic? In this paper, we look at underlying factors that determine India's status to tackle a pandemic and also generate informed discussions on some of the mind-tickling
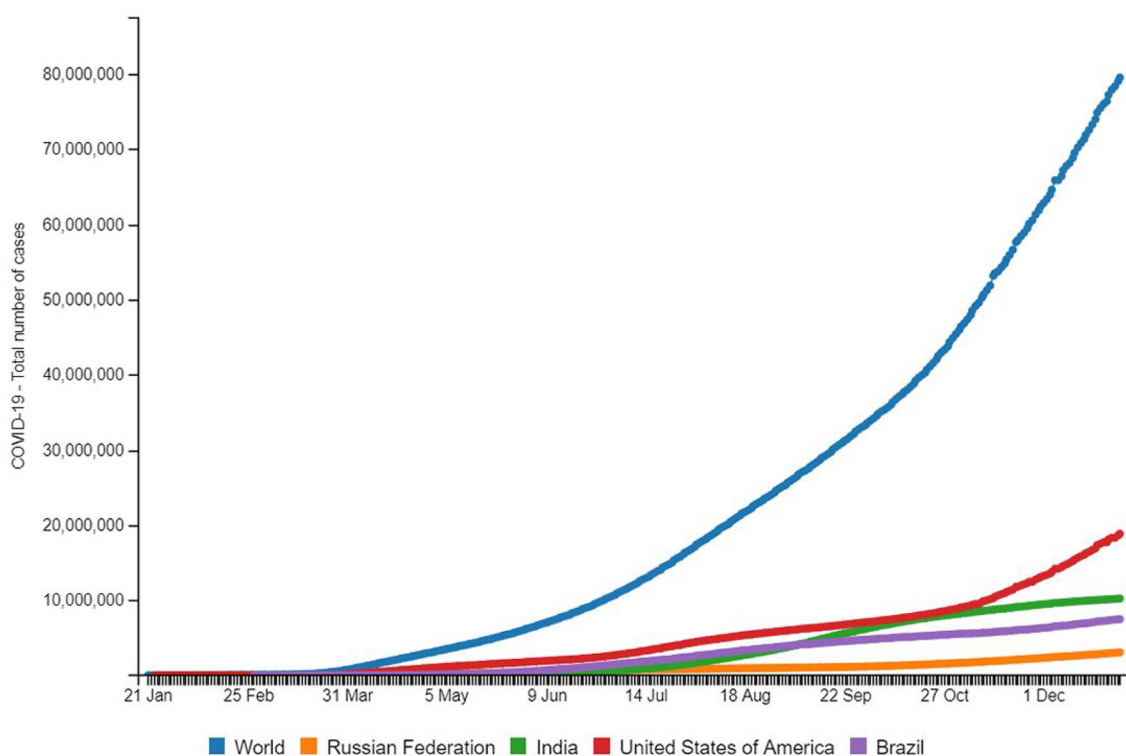
FIGURE 1 | Source: http://www.smaartrapidtracker.org, accessed on December 29, 2020. Total number of cumulative cases of COVID-19 in the world, Russia, United States of America, Brazil, and India (January 21, 2020 to December 29, 2020).

queries that can support and guide public health efforts in the region by analyzing epidemiological data accessed from SMAART (Sustainable, Multisector, Accessible, Affordable, Reimbursable, and Tailored) RAPID (Research-enabled Action-oriented Policy Interventions driven by Data) Tracker.

SMAART RAPID Tracker

SMAART is a Population Health Informatics (PopHI) framework designed using principles of data, information, and knowledge (DIK); human-centered approach; cognitive fit theory; information processing theory; and humanistic, behavioral, and learning theories (1). As an interactive dashboard, SMAART RAPID Tracker was designed in response to the rapidly changing landscape of both the incidence and mortality of COVID-19 as well as the great variance in policy actions across the globe. The RAPID Tracker is a policy informatics tool using the SMAART informatics framework to track the geospatial spread of the novel coronavirus outbreak and policy actions globally. The platform facilitates the integration of data related to the novel coronavirus with the policy actions of various governments globally. This provides a unique opportunity to evaluate the impact of the policies on the spread of the COVID-19 outbreak.

As an interactive dashboard, SMAART RAPID (Research enabled Action oriented Policy Interventions driven by Data) Tracker designed in response to the rapidly changing landscape of both the incidence and mortality of the novel coronavirus

(COVID-19) as well as the great variance in policy actions across the globe. The platform facilitates integration of the novel coronavirus (COVID-19) related data with policy actions of various governments globally. The dashboard aggregates publicly available but verified information on the burden of the novel coronavirus (COVID-19) as well as aggregating policies/advisories and the timeline in which they were enacted for each country. This structure emphasizes the importance of considering both the epidemiological and political realities to understand what types of non-pharmaceutical interventions are effective. This becomes even more important with the resurgence of cases in countries and areas that previously experienced declines.

SMAART Rapid Tracker has 4 modules including (a) a data module that gathers COVID-19 related data on community wide transmission, total and new confirmed cases, recovered cases, and total and new fatality rates across global settings; (b) a policy module that facilitate users to examine the impact of policies and advisories on COVID-19 trends; (c) an insights module that aims to track trends and analysis of COVID-19 globally; and (d) a digital resource module that aims to aggregate national and global digital resources available that are related to COVID-19. SMAART Rapid Tracker is operational on Wordpress, an open source platform. The technology stack includes HTML, CSS, and JavaScript libraries as frontend, PHP 7.3 as server-side script, and MySQL 8.0 as the database. The dashboard is cross browser

compatible and completely responsive on mobiles and tablets. The SMAART RAPID Tracker id designed using principles of an existing human-centered, geovisualization platform, SanaViz, an Internet-enabled, interactive app incorporating principles of human-centered design and cognitive fit theory to enhance visual exploration of population health data. In addition, similar principles have been used to design and develop the ETE dashboard tool developed to track New York's progress toward achieving the goal of its ETE initiative, to reduce new HIV infections from 3,000 per year to 750 per year by the end of 2020.

The immense burdens placed on the most vulnerable groups entangle this image undeniably, as brought to light by relevant epidemiologic trends. Developing proof demonstrates disability and incapacity due to the coronavirus for racial-ethnic minorities at disproportionate levels given the comparative transmission rates among other segments of population around the world (4). The presymptomatic and asymptomatic spread has caught us by surprise and has led to a rapid spread of infection while scientists are still trying to explore the constantly mutating novel virus.

Epidemiology of COVID-19

In 2020, Bill Gates indicated in a TED interview that the transmission dynamics of COVID-19 are known to be more difficult than what experts predicted (5). The first cases were reported in December 2019, and from December 18, 2019 to December 29, 2019, five patients were hospitalized with acute respiratory distress syndrome, and one of these patients died (6). India reported its first COVID-19 case on January 29, 2020 from a group of students returning from Wuhan, China, to Kerala (7). Within 5 days, the number recorded increased to three and stayed the same until March 2020 (6, 7). Throughout February, no major control measures were taken other than temperature screening of people returning from China at major airports. On March 4, 2020, the number of cases increased to 22, including 14 Italian tourists (7).

An understanding of the virus' genomic attributes helps discern its pathogenesis. "Genome Composition and Divergence of the Novel Coronavirus (2019-nCoV)" shows significant differences between SARS or SARS-like CoV and COVID-19 (8). COVID-19 is mainly transmitted through respiratory droplets or fomites from an infected person via mucous membranes of the mouth, nose, and eyes (9), with the average incubation period ranging from 5 to 6 days (9). The risk of transmissibility of COVID-19 to the reproduction of the virus (Ro) is 3.28, much more than the WHO's range of 1.4–2.5 (10). Ro is an indication of the transmissibility of a virus representing the average number of new infections generated by an infectious person in a vulnerable population (for R0 > 1, the number of infected individuals is likely to increase, and for R0 < 1, the transmission is likely to die out). The basic reproduction number is a central concept in infectious disease epidemiology indicating the risk of an infectious agent concerning epidemic spread (9); it indicates that around three persons will be infected by an index patient. These reproduction estimates of the infectious agent in a population of 1,380,937,553 (making it 17.7% of the world population) estimated as of July 27, 2020 based on Worldometer elaboration of the latest United Nations (UN) data, with a population density of 1,202 people per square mile (10), suggests high priority, timely national responses from the government. Was the government of India prepared for this?

CHALLENGES UNIQUE TO INDIA

Government Action—Boon or Bane?

In a country of ~1.3 billion people, Hinduism is the most common religion in India, accounting for about 80% of the population; Islam is the second-largest religion comprising 13% of the population; and other major religious groups in India include Christians (2.3%), Sikhs (1.9%), Buddhists (0.8%), and Jains (0.4%) (11). Due to the socio-economic pattern and cultural and religious values of India, the challenges posed by COVID-19 are very different compared to its European counterparts. On March 19, 2020, at a point prevalence of 500 (1), Prime Minister Narendra Modi announced a "janata curfew" for March 22, 2020, in what was seen as a mock drill to prepare citizens for a longer lockdown in the future (12, 13). This lockdown was aimed at stalling the spread of the virus. The lockdown in India represents a massive logistical and implementation challenge given the population size and its density. Despite the government's measures to address crises like distributing food on a large scale, pressing employers to pay wages, and landlords to waive rents, panic and uncertainty especially among the migrant laborers resulted in them traveling, sometimes even by foot, hundreds of miles to their villages back home.

India's largest lockdown ever began with a 4-h notice, when Narendra Modi announced at 8 p.m. on March 24, 2020 that the entire country would be brought under curfew from midnight to curb the spread of COVID-19 (13). At the time, there were only 320 recorded cases confined to a few regions and 10 deaths in a population of more than 1.3 billion (1). In a matter of months, India became one of the worst-affected countries globally (14). This increase has been attributed to augmented testing and spread of the infection, despite one of the most stringent lockdowns in the world.

Information collected from media sources yielded a government response that included a prolonged lockdown, a public awareness campaign, and a series of innovations including a novel smartphone application called Aarogya Setu for the purpose of contact tracing and aiding in quarantine and related containment measures (15). After assessing the government's actions closely, the question "if India had handled the pandemic differently, would it be in a better position?" arises. In this review we look at the COVID-19 situations in Vietnam and Pakistan and also propose a tool in the form of an asset-based framework that would assist decision makers as there seem to be complex multidimensional forces at play.

Geopolitical Challenges and Socio-Economic Impacts

In December 2020, India witnessed the largest protest of this century; an estimated 250 million farmers traveled hundreds of miles in solidarity with strikers, protesting against three new agricultural laws that were drawn in September (16). These laws were enacted under the auspices of modernizing the

agricultural industry and permitting entry of big agro-business corporations in agriculture and therefore weakening the already shaky structure of the Indian democracy (16). Approximately 65% of the India population is associated with agricultural professions (17). Suicide rate for farmers are higher than other sectors globally (17) and the current protests by unmasked farmers during a pandemic is expected to have adverse outcomes given the etiology of COVID-19. A total of 10,224,303 COVID-19 cases have been reported in India as of December 29, 2020, of which 761,494 are new cases in the month of December 2020 alone (1).

The contentious Indo-Chinese situations during this pandemic are considered to be one of the worst geopolitical challenges currently ongoing in Asia. On June 15, 2020, China initiated an attack on armed forces at the Indian border amidst an ongoing pandemic (18). It triggered a series of protests that brought people into the streets to campaign against the use of Chinese products and software applications. Mass gatherings affected the observation of social distancing guidelines from the local, state, and central health authorities, which subsequently impacted overloaded medical systems and healthcare personnel. **Figure 2** shows a spike of new cases (36.08%) recorded around June 24, 2020 in a 7-day average change in new cases from June 15, 2020 to July 15, 2020 (1). Considering an average incubation period of 5–6 days, data suggests that these mass gatherings could have been one of the factors that triggered higher infection rates.

In addition to India's healthcare system being adversely affected by the current pandemic, international relations have also suffered a setback. According to the Ministry of Statistics and Program Implementation in India, the growth rate of the country has dropped to 3.1% (14), and the UN report "The World Economic Situation and Prospects" as of mid-2020, projects India's growth rate to fall to 1.2% in 2020 (19). The trade impact for India is estimated to be ~348 million dollars and the figures indicated India to be among the top 15 economies most affected as slowdown of manufacturing in China disrupts world trade (19). For India, the trade impact is estimated to be the most for the chemicals sector at 129 million dollars, textiles and apparel at 64 million dollars, automotive sector at 34 million dollars, electrical machinery at 12 million dollars, leather products at 13 million dollars, metals and metal products at 27 million dollars, and wood products and furniture at 15 million dollars (19, 20). This has come as a direct consequence of the spread of coronavirus (COVID-19). When we see China's share in total imports to India, India's total electronic imports account for 45% of China. Around one-third of machinery and almost two-fifths of organic chemicals that India purchases from the world come from China. For automotive parts and fertilizers China's share in India's import is more than 25%. Around 65–70% of active pharmaceutical ingredients and around 90% of certain mobile phones come from China to India.
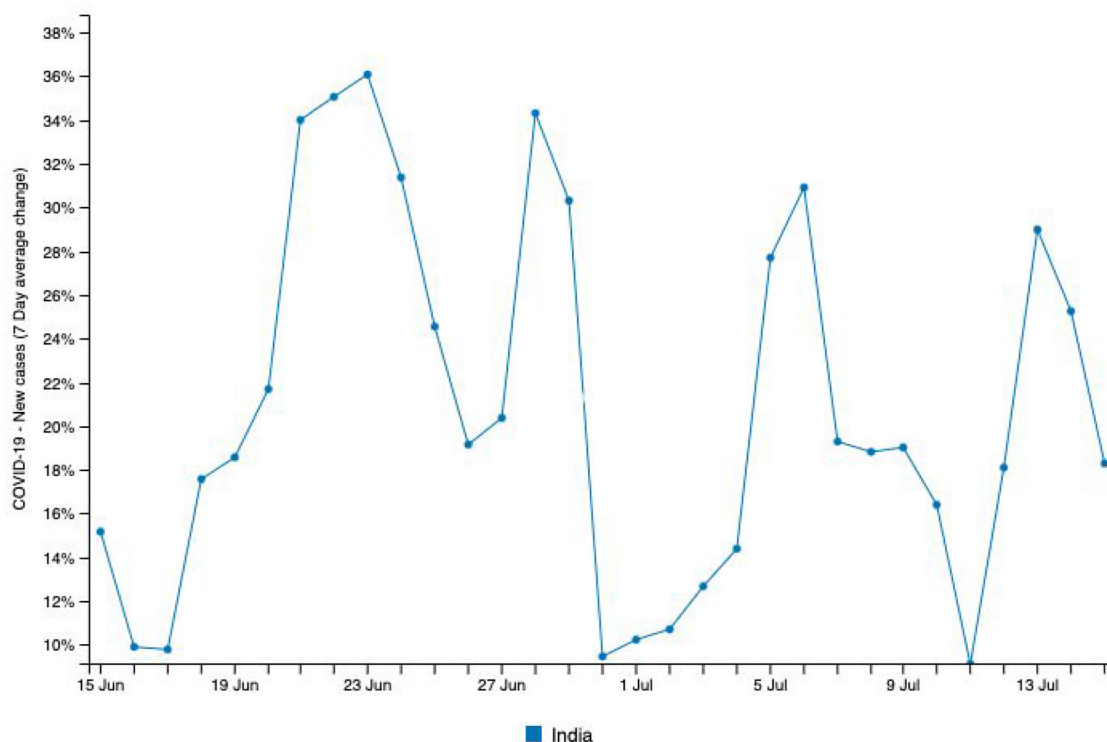
FIGURE 2 | Source: http://www.smaartrapidtracker.org, accessed on July 27, 2020. The New cases (7 Day average change) of COVID-19 in India (June15, 2020, to July 15th, 2020).

India's Chief Economic Advisor Dr. Krishnamurthy Subramanian said that trade between India and China—which grew from $3 billion in 2000 to an all-time high of $95 billion in 2018—is largely in China's favor (20). China's exports to India are four times higher than its imports from India. India's trade deficit with China is the single largest it runs with any country as Chinese investors poured millions of dollars into India's largest new-age companies (20). These economic and internal security changes provide compounded roadblocks that are unique to India in dealing with this pandemic.

Given the nature of the disease which is highly contagious, the ways to contain the spread include policy actions such as imposition of social distancing, self-isolation at home, closure of institutions, and public facilities, restrictions on mobility, and even lockdown of an entire country. These actions can potentially lead to dire consequences for economies around the world. In other words, effective containment of the disease requires the economy of a country to stop its normal functioning. A stimulus of 20 trillion Indian rupees was passed as a response to this health crisis (21). The country's corporate credit in June 2019 was greater than that of June 2020, suggesting that banks did not access much of this emergency fund. Recuperation through investment has stalled and companies have deleveraged resigning old obligations (21). The use of electricity, petrol, and diesel are beginning to recover post the initial lockdown lows but have still been 10–18% below that of what it was in June 2019 (22). There has been a 23.5% spike in unemployement that continues to asscend marginally (22). Due to the lack of infrastructure, although over half of India has access to smartphones, relatively few can work remotely. Jobs related to retail and manufacturing require physical presence and interaction and have been directly impacted (21, 22). Although the Mahatma Gandhi National Rural Employment Guarantee Act (MNREGA) supports 100 days guaranteed employment, it does not cover urban areas. Critically, the larger firms are perceived healthier. Laborers are struggling to get paid by the micro, small, and medium-sized enterprises (MSMEs) that are intermediate inputs and service suppliers to the modern sector (21, 22). However, small and micro enterprises, which are the largest source of employment outside agriculture, have minimal access to formal credit and constitute 99.2% of all MSMEs (22). Their inability to bounce back could see India face further economic and social tensions. The economy is withstanding both supply and demand shocks with the wholesale prices index declining sharply (21, 22).

Population Density and Weather

India's high population density brings together another challenge in managing this widespread pandemic. It's two megacities, New Delhi and Mumbai have a population density of 29,259.12 and 73,000 per square mile, respectively, being some of the most densely populated cities in the world (11). Because property prices are at such a premium, residents of Mumbai frequently live in low-cost, cramped housing located far from their workplace, leading to long commutes on the city's busy mass transit system. Comparatively, New Delhi covers a larger area than Mumbai (11). Social distancing in such densely populated cities along with 10–15% of these cities' populations being illiterate coupled

with cultural practices that facilitate gathering in groups might contribute to the emerging infectivity rate (23). For these dense communities in India, inadequate shelter and overcrowding are also some of the high risk factors aiding in transmission of the virus. According to a recent report by the National Centers for Disease Control (NCDC), unauthorized colonies and jhuggi-jhopri clusters pose a serious problem as a large number of people live in these colonies (24). A "jhuggi-jhopri" refers to a small roughly built house or shelter usually made of mud, wood, or metal that has thatched or tin-sheet roofs and a "slum" refers to an area consisting of poorly built, overcrowded clusters (17). Residents of these inadequate housing facilities usually lack access to adequate sanitation facilities, and self-isolation is often impossible.

While attempting to fight off the coronavirus, India has also been suffering a heat wave that has worsened the crisis as residents struggle to stay home. Temperatures soared to nearly 110° Fahrenheit in New Delhi in late May 2020, making wearing a mask unbearable to some and social distancing harder to maintain in close proximal housing settings (10). This heatwave has definitely dealt a setback while dealing with the virus; additionally, India had to also deal with devastating floods and landslides triggered by torrential rains in various parts of the country. The hard-hitting monsoon in India has affected 16 states and millions of people, resulting in a loss of roughly 900 lives while disrupting normalcy (25). The highest number of deaths this monsoon due to floods and landslides was recorded in the state of West Bengal where 239 people died, followed by 136 in Assam, 87 in Gujarat, and 74 each in Karnataka and Madhya Pradesh (26). On August 7, 2020, heavy rains majorly impacted the southern state of Kerala and claimed the lives of 49 people (26). Approximately six million people in Bihar and over five million people in Assam have been displaced and have abandoned their livestock and livelihood (26). Rivers are flowing above the danger level in almost all states making it difficult to monitor the exact number of casualties in those areas and aggravating the suffering of families of missing persons. Displaced persons taking shelter in refugee camps deployed by the National Disaster Response Force (NDRF) and the State Disaster Response Forces (SDRF) are making social distancing guidelines recommended by the center very difficult to follow (26, 27). Refugee camps make physical isolation impossible and people live in insanitary and inhospitable conditions. Sometimes, up to six families live in one tent within a 3 m^2 area (27). Limited infrastructure to deal with COVID-19 in these camps puts these vulnerable populations at an even greater risk. According to Nott (2020), "apart from difficult living conditions in these camps, many people share one latrine and washing facilities and hundreds queue for food every day" (27). The deluges in India cause similar damage every year, pushing millions into greater poverty due the loss of habitat, creating a snowball effect. This condition is proving dire for the disease burden.

Testing and Recovery

According to data gathered from SMAART RAPID Tracker, the incidence rate of COVID-19 recorded in India is calculated at ~35.73% (per million) (1). The infectivity rate of COVID-19

in India has been calculated at around 0.9% with ~817,209 recovered cases and a total fatality of 30,601 cases as of August 6, 2020 (**Figure 3**) (1). These inferences are based on data available from laboratory testing and diagnosis for identification of COVID-19 cases, which is critical in order to identify and isolate positive patients to contain the spread of the pandemic. Most treatment decisions in clinical settings are based on laboratory outcomes. In India, the availability of tests was identified as a challenge when the pandemic just hit the country; an average of only 1,500 samples were tested daily until early April 2020 (28). While health experts noted that efficient testing would be vital to containing the spread of COVID-19, inadequate testing data from India before mid-April suggests delayed identification and isolation of positive cases. Literature reports that contact tracing of identified cases and quarantining of those infected can slow the spread of infection. Diagnostic testing for COVID-19 which helped companies supply their own tests to government and private laboratories, hospitals, and other clinical settings served as cushioning in safeguarding growing testing capabilities.

A total of 1,415 operational laboratories in India are testing for COVID-19 as of August 10, 2020; Real-time polymerase chain reaction (RT-PCR): 720 (government: 431 + private: 289), TrueNat Test: 584 (government: 481 + private: 103), and CBNAAT Test: 111 (government: 32 + private: 79; 21) (28). The states of Maharashtra, Tamil Nadu, and Andhra Pradesh have reported the highest number of cases as of August 10, 2020

(1). **Table 2** provides a snapshot of the testing capabilities in the few highly impacted states of the country. This table helps us understand the availability of Indian laboratories in testing samples to identify and isolate positive cases. Maharashtra is known to be the hardest hit with a burden of 1,928,603 cases as December 30, 2020 (1). This western state is considered a hotspot that accounts for nearly one-third of the total cases as well as ~40% of deaths in India (1). Even though the fatality rate of 4.3% is lower than that of the rest of the world, it is significantly higher than that of the other Indian states (29). As of August 10, 2020, there were a total of 142 pathology laboratories for coronavirus testing in Maharashtra, including 77 government and 65 private laboratories (28). Mumbai, the largest city in the state of Maharashtra, is the most densely populated city in the entire country and has constantly had the highest number of COVID-19 cases in the country.

Both **Tables 1**, **2** help us identify a possibility of correlation between testing availability and incidence and mortality caused by the virus. Areas that are robustly testing are able to identify and curb the growing trends, and hence, testing availability at the right time is crucial. A multitude of factors such as testing availability, laboratory facilities, and caveats in testing and data reporting contribute to the burdens of India's pandemic support structure. In the early stages of the pandemic, testing kits were not easily available and were used only in symptomatic cases following strict guidelines and in select public testing facilities. A
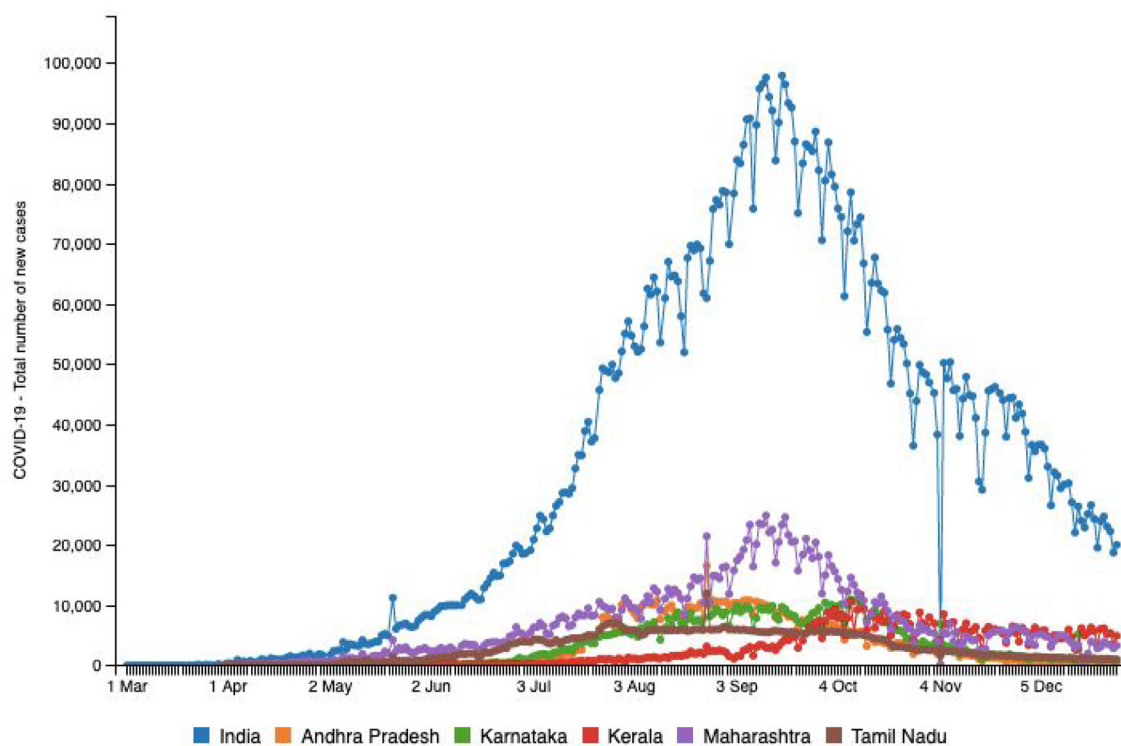
FIGURE 3 | Source: http://www.smaartrapidtracker.org, accessed on December 29, 2020. Status of COVID-19-Total number of new cases in India, and in the states of Maharashtra, Andhra Pradesh, Delhi, Karnataka, Uttar Pradesh, and Tamil Nadu (March 1, 2020 to December 29, 2020).

TABLE 1 | Source of Data: http://www.smaartrapidtracker.org, accessed on August 6, 2020.

Country	Population	Total tests	Total cases	Total recovered
USA	331,192,837	62,768,388	5,000,443	2,552,190
Brazil	212,706,570	13,329,028	2,873,304	2,020,637
India	1,381,307,956	22,149,351	2,025,409	1,377,384
Russia	145,940,753	29,716,907	871,894	676,357
South Africa	59,381,566	3,149,807	529,877	387,316
Iran	84,097,623	2,612,763	320,117	277,463
UK	67,922,029	17,515,234	308,134	N/A
Italy	60,452,568	7,099,713	249,204	201,323
Germany	83,811,260	8,586,648	215,100	196,200
China	1,439,323,776	90,410,000	84,565	79,088

Table with testing numbers, new cases, and recovered cases for some highly affected countries as of August 6, 2020.

TABLE 2 | Source of Data: Indian Council of Medical Research https://www.icmr.gov.in/, accessed on August 10, 2020.

State	Govt. labs	Private labs	Cases per million	New cases	Total recovered	Total fatality
Maharashtra	77	65	4,586	12,248	351,710	17,757
Tamil Nadu	61	70	4,116	5,994	238,638	4,927
Andhra Pradesh	67	9	2,691	10,820	138,712	2,036
Karnataka	45	56	2,913	5,985	93,908	3,198
Delhi	23	39	8,681	1,300	130,587	4,111
Uttar Pradesh	120	40	614	4,571	72,650	2,069

Table with laboratory numbers, cases per million, total recovered, and total fatality for some highly affected Indian states as of August 10, 2020.

BBC report indicated that the most common test used in India is the RT-PCR test that isolates genetic material from a swab sample (30). While they are considered the benchmark of COVID-19 testing, they are India's most expensive test, taking 8 h to process and up to 24 h to provide results, depending on transport time to laboratories (30). In a bid to boost testing capacity, India opted for rapid antigen tests, commonly known as diagnostic or rapid tests. These are cheaper, and by isolating proteins (called antigens) that are unique to the virus can offer results in just 15–20 min (30). However, the Indian Council of Medical Research (ICMR) evaluations found that their accuracy rates were as low as 50%, while the All-India Institute of Medical Sciences (AIIMS) found their accuracy in giving a true negative result ranges from 50 to 84% (28). **Figure 3** highlights the number of new cases reported in the above-mentioned six states in comparison with country-wide data until December 29, 2020. **Figure 4** provides an outline of new fatalities reported in the same states until December 29, 2020. Comparing the slopes of **Figures 3**, **4**, we can propose a compelling rationale for strong consideration of proportionality in new cases against new fatalities (1). Infections are rapidly rising in these states, yet the recovery rate continues to rise and now stands at ∼63.5% (1). Can we credit India's ancient Ayurveda and alternative medicine practices to this growing recovery rate or the median age of 28.4 years making it one of the youngest populations in the world enabling uncompromised immune systems?

COVID-19 in Vietnam and Pakistan

China borders an expansive 795 miles of Vietnam and the shortest distance via air between the two countries is 1,313.41 miles (10). Vietnam was at a high risk owing to its proximity to China and the high rate of coronavirus transmission. However, two cases were reported on January 24, 2020 (1), and only 1,414 cumulative cases by December 22, 2020 (1). **Figure 5** helps us visualize the relatively low incidence rates in this middle-income, developing Asian nation, raising curiosity about the government's policies and procedures to tackle the spread of COVID-19, given that it is a nation with limited resources and a high population (1). While the rest of the world is still grappling with the severity of rising infections, Vietnam has demonstrated a strikingly low number of fatalities of only 35 people until December 22, 2020 in comparison with Pakistan and India at 9,392 and 146,111, respectively (1). As seen in **Figure 6**, the rate of infection in Vietnam has been evidently much lower in comparison with nations like Japan, Turkey, the Philippines, Egypt, and Congo, that have similar populations (10). Vietnam's policy responses to the outbreak was reviewed by La et al. (2020), and they identified 173 official instructions, guidelines, plans, dispatch, policies, and direct actions that were issued by the government until April 4, 2020 (31). A couple of days after China affirmed the flare-up of COVID-19, the Ministry of Health (MOH) in Vietnam issued a mandate for identified cases to isolate (32). On January 10, 2020, the Public Health Emergency Operation Center held a briefing
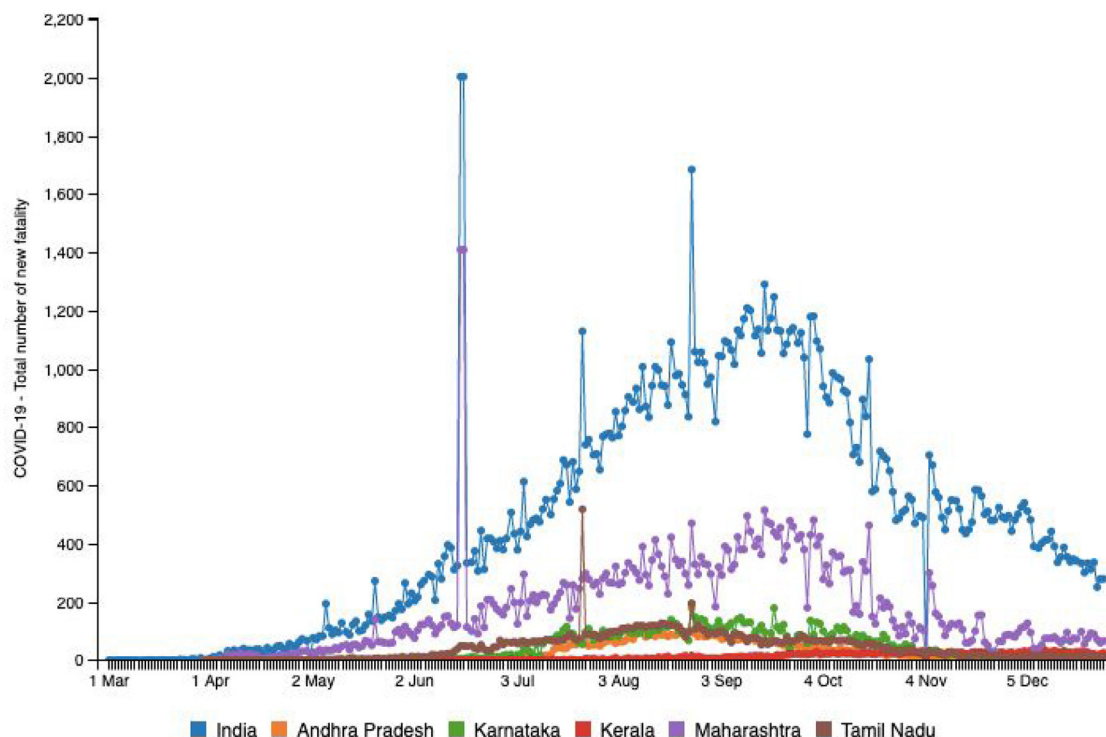
FIGURE 4 | Source: http://www.smaartrapidtracker.org, accessed on December 29, 2020. Status of COVID-19 Total number of new fatality in India, and in the states of Maharashtra, Andhra Pradesh, Delhi, Karnataka, Uttar Pradesh, and Tamil Nadu (March 1, 2020 to December 29, 2020).

to assess the situation and respond (31, 32). The website (http://ncov.moh.gov.vn) was launched as an innovative initiative. The NCOVI and Vietnam Health applications were introduced to supply nationals with timely data and live-chat features (31). On February 1, 2020, public authorities announced an emergency because six new cases had been identified. What followed were severe measures to keep the infection from spreading, including isolation, disconnection of suspected infection transporters, and willful seclusion at the network (32).

Pakistan, with ∼212 million inhabitants, is the fifth most populous country in the world and shares its borders with China, India, Afghanistan, and Iran (11). The first COVID-19 case was confirmed by the Ministry of Health, Government of Pakistan, on February 26, 2020 in Karachi, Sindh province (33). By December 22, 2020, Pakistan had confirmed 458,968 cumulative cases (**Figure 7**). The Government of Pakistan has established a COVID-19 Relief Fund to receive donations for public welfare. Social network helplines were launched by the government in seven local languages (33). Every medical organization that was supporting the treatment of COVID-19 positive patients was required to conduct "need and availability assessment" of supplies equipment, personal protective equipment (PPE), and laboratory diagnostics, including identification of sources to ensure provision and availability of these (34). Pakistan also observed an uptick in suicidal rates during and after the pandemic, most of these suicides occurring due to a lockdown-related socioeconomic distress and the fear of infection (34, 35).

MSMEs were also severely victimized (35). In a study conducted by Shafi et al. (36), two-thirds of participating enterprises reported that survival would be difficult if the lockdown lasts more than 2 months (36). There was also a disruption in routine immunization and other health services, which adversely impacted the common people (37). Another worry is the impact of sewage waste and drainage on groundwater as the presence of COVID-19 in stool has been fundamentally revealed in literature (38). Groundwater pollution is getting more serious in nations like India, Bangladesh, and Pakistan, where waste is released into water bodies (38). A host of impurities and microorganisms weaken groundwater quality, and the presence of stool in sewage channel water prompting groundwater contamination can be an arising danger and could facilitate further spread of COVID-19 (38). This plague has also caused the disruption of other health care services, routine immunization being one of them. This could possibly onset secondary outbreaks of vaccine-preventable diseases and eventually exacerbate immunization disparities (39).

NEED FOR A POPULATION HEALTH INFORMATICS SURVEILLANCE PLATFORM

A conceptual framework is an analytical tool with the ability to be applied to various settings. As seen in the literature, the COVID-19 pandemic suffering has been heightened due
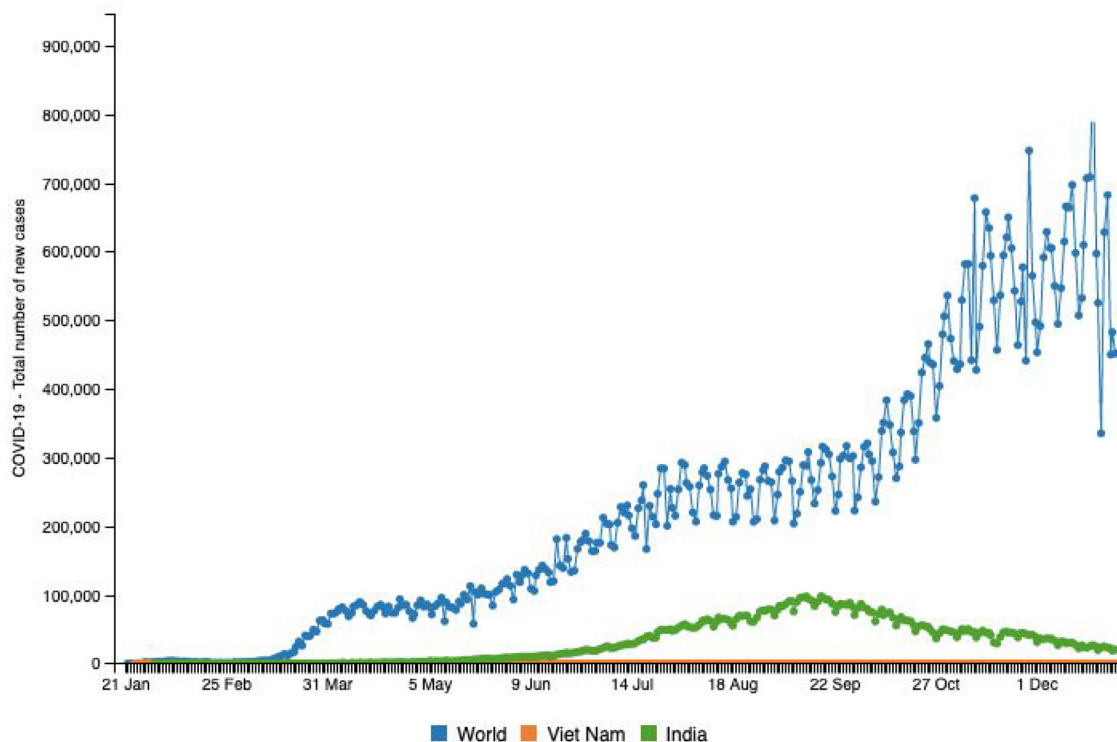
FIGURE 5 | Source: http://www.smaartrapidtracker.org, accessed on December 29, 2020. Total number of new cases of COVID-19 in the world, Vietnam, and India (January 21, 2020 to December 29, 2020).

to human rights failures, but the right to health can provide a base for guaranteeing that the pandemic response serves to realize the right to the highest attainable standard of physical and mental health for all (40). The CDC provided a framework to local governments to respond to the plague (41). The framework aims to protect high risk individuals (e.g., 65 years of age and above, those with underlying medical or health conditions, etc.), vulnerable populations (e.g., refugees, internally displaced persons, prisoners), first responders, healthcare personnel, and critical infrastructure workers (41). Adapting interventions such as these, if supported by existing public health programs helps address the immediate mitigation needs. The UN provides a methodology and outline to dire financial reactions of the pandemic, following the Secretary-General's report on the socioeconomic impacts of the COVID-19 emergency (42). This tool's emphasis is placed on the present time and setting at a national level. The UN development system (UNDS) is supporting wellbeing frameworks, food security frameworks, reestablishing and working to better their fundamental and social administrations, and adopting unique measures to limit the effect of the pandemic on the most weak populaces (42). The UNDS themselves is ensuring the implementation of framework during the COVID-19 emergency; simultaneously, it is helping secure individuals through social insurance and ensuring occupations, little, and medium-sized undertakings, and the weak specialists in the casual area through

monetary recuperation. The framework is also helping direct an important flood in financial and monetary boost to make the macroeconomic structure work for the most defenseless, encourage supportable turn of events, and reinforce multilateral and territorial reactions (42). This will fabricate trust through social discourse and political commitment as well as put resources into a network driven flexibility.

For surveillance of COVID-19 and its cause, the implementation of syndromic surveillance and commercial laboratory reporting needs to be designed and executed to address the gaps. A population health informatics surveillance system has the ability to draw from a combination of data sources and create an updated, more accurate picture of the disease's spread, its effects, and generate specifics necessary to inform the national public health response to COVID-19. Based on our understanding of the challenges faced by developing Asian nations, it is critical to have robust surveillance in place to control the spread of COVID-19 as a system of this nature will enable rapid detection, isolation, testing, management of suspected cases, application of prevention measures, and detection and containment of further outbreaks among vulnerable populations. It will also support evaluating the impact of the pandemic on the health-care systems and society, monitoring long term epidemiologic trends and the evolution of novel diseases, and assess the association between COVID-19 and other viruses (43).

FIGURE 6 | Source: http://www.smaartrapidtracker.org, accessed on December 29, 2020. Total number of cumulative cases of COVID-19 in the world, Vietnam, Japan, Philippines, Turkey Egypt, and Congo (January 21, 2020 to December 29, 2020).
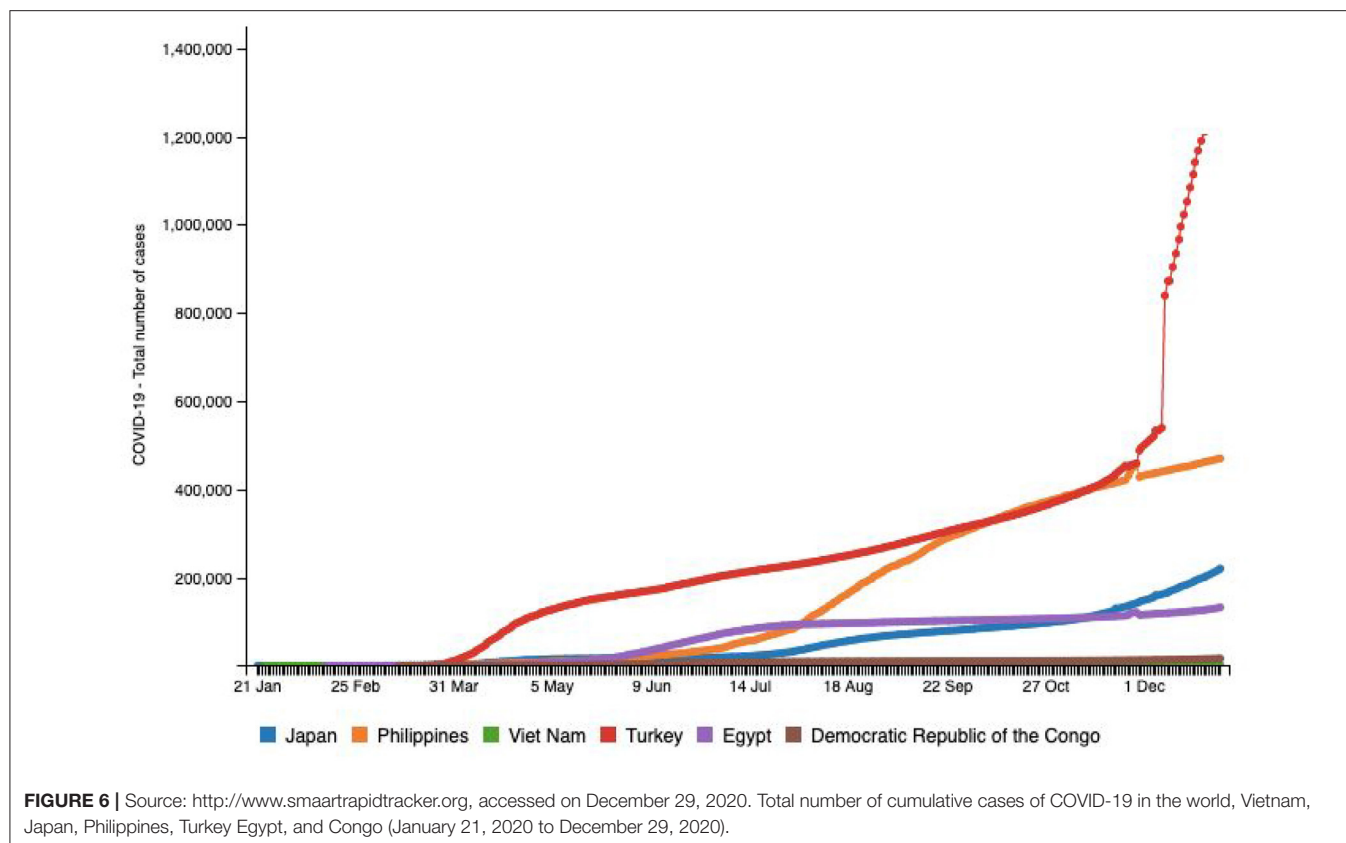
On the policy level we suggest that apart from the spatiotemporal data collection and case notification of COVID-19 as proposed by WHO, information regarding signs and symptoms of COVID-19 and laboratory assessment combined with information related to individual socio-demographics, physical environment, health behaviors, additional clinical assessments, and knowledge attitude and practices should also be recorded. As discussed, there are a multitude of factors that influence the outcome of the COVID-19 pandemic. Information on socio-demographic variables (like age, gender, education, and income) and physical environments (like built in environments such urban, rural, or slum settings) is also essential to record and determine both at risk populations and vulnerable settings. Data on health behaviors including variables such as sleep patterns, alcohol consumption, diet, and physical activity patterns are essential to determine their association with individuals being confined due to the pandemic. Despite the extraordinary national measures in combating the outbreak, the success or failure of these efforts is largely dependent on public behavior. Public adherence to preventive measures established by the government is of prime importance to prevent the spread of the disease. Adherence is likely to be influenced by the public's knowledge and attitude toward COVID-19. Evidence shows that public knowledge is important in tackling pandemics (44). Hence, it is essential to have COVID-19 related knowledge, the populations attitudes, and their practices as a part of the surveillance system. By assessing

public awareness and knowledge about the coronavirus, deeper insights into existing public perception and practices can be gained, thereby helping to identify attributes that influence the public in adopting healthy practices and responsible behaviors (44). Assessing public knowledge is also important in identifying gaps and strengthening ongoing prevention efforts. Combining multifaceted subjective and objective data using the DIK (Data, Information, Knowledge) framework will help generate the risk profile of an individual and the community. A human-centered approach combined with information processing theory and humanistic, behavioral learning, and self-efficacy theories will facilitate feedback based on user engagement, task analysis and requirements, and on individual classification into prevention, monitoring, and referral ad management categories. These would be evidence based and would guide the development of programs, policies, and interventions driven by data (**Figure 8**). In addition, population health informatics enabled surveillance systems should guide outcome assessment of variables including process, clinical, quality of life, cost effectiveness, and longevity (**Figures 8**, **9**).

DISCUSSION—PUBLIC HEALTH AND POLICY IMPLICATIONS

At present, India faces a triple burden of diseases—infectious diseases, the challenge of non-communicable diseases, and
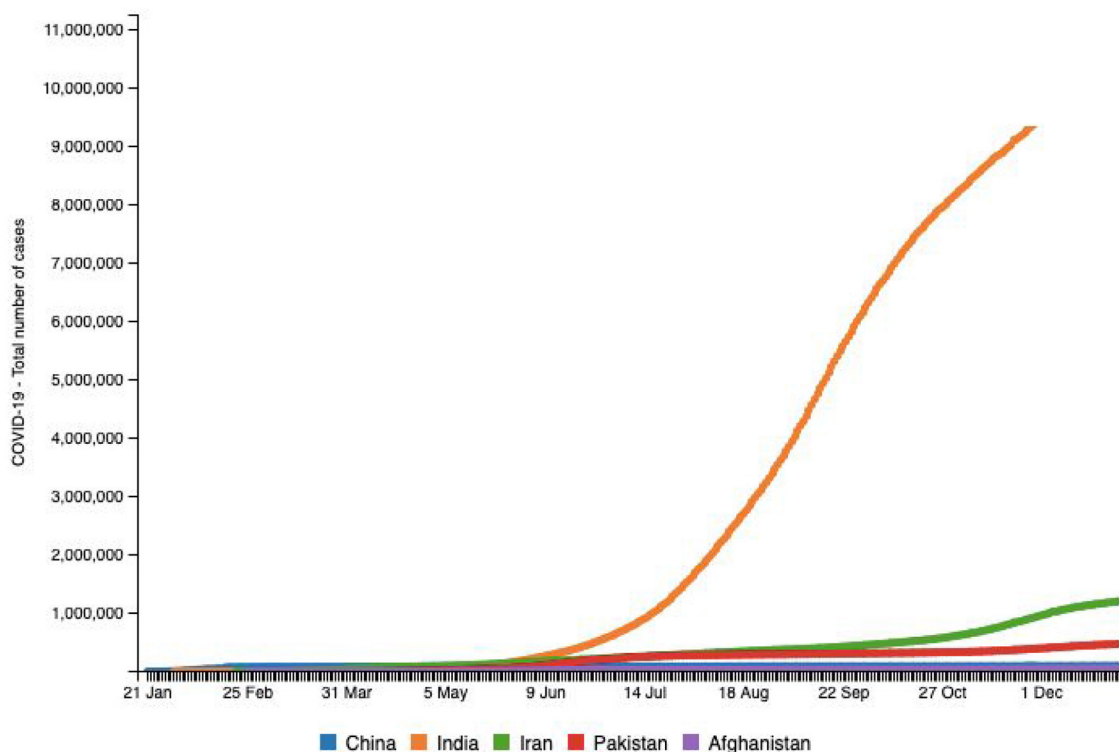
FIGURE 7 | Source: http://www.smaartrapidtracker.org, accessed on December 29, 2020. Total number of cumulative cases of COVID-19 in the world, China, India, Iran, Pakistan, and Afghanistan (January 21, 2020 to December 29, 2020).

emergence of the COVID-19 pandemic. Topping the disease caseload, challenges unique to India in these trying times discussed in this paper make tackling the pandemic complex, unless the existing health infrastructure in India that is already over-stretched is strengthened to face these challenges in the 21st century.

Prior to commencement of lockdown four in India on May 18, 2020, the country was focusing on national decisions; it then switched to a state-based approach where each state devised its own policies and regulations. States implemented zone-based policies depending on the extent of cases. Bearing in mind this pandemic, extreme vulnerabilities were exposed in a host of aspects surrounding the coping mechanisms of a country, be it the drug supply chain of a nation, information systems, or government compositions. These interdisciplinary shortcomings could possibly present similar, if not worse, implications in a future health disaster; and as public health professionals, our responsibility to safeguard the vulnerable populations in that future are looming large. Key findings in literature framing the problem of structural determinants of health disparities in a pandemic focus on reliability of data, national policy, and surveillance characteristics among social inequality, interpersonal relationships, and biopsychosocial-related weathering. The conceptual model (**Figures 8**, **9**) includes elements of an integrated cumulative pathways approach, which posits that efforts to support these pathways will result

in a strapping coping system for future health disasters. A shortage of PPE in India and fragility of the medical equipment stockpile was a result of the accumulated lack of effort over time, indicating that little attention is paid to factors that undermine efforts to protect frontline health-care workers. The addition of public health advisors in the Indian cabinet will enhance administrative response efforts surrounding stocks of health supplies and ensure that front-line workers have all the essential equipment to protect themselves during this pandemic.

Research studies should focus on learnings from the ongoing challenges and the knowledge generated from this research can be utilized to strengthen the information economy and provide evidence-based solutions. As discussed earlier in this paper, we made suggestions about the stable increase in the recovery rate of Indians for COVID-19, possibly hinting at accrediting a higher recovery rate due to natural preventive medicine practices than that of its counterparts. Studies should focus on these ancient practices of the Indian heritage that assist infected patients in fighting the effects of this disease. Efforts to create integrated systems for data management are also calling for action as lack of testing data during the current pandemic has caused misreporting and underestimation of the severity of this disaster. Access to testing data by the state in real time, hospitalizations, availability of beds per state, and supplies available to each state should be made available to
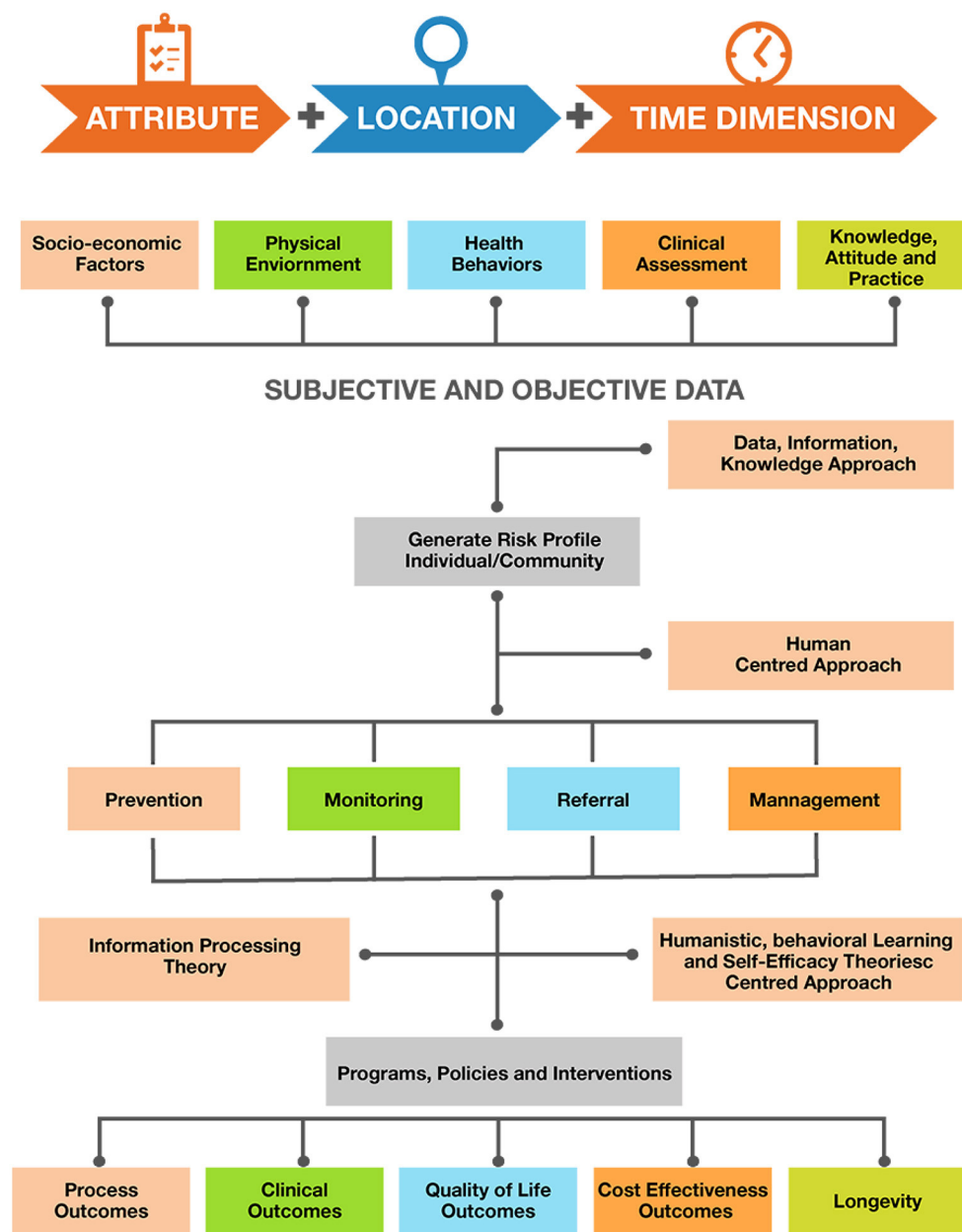
FIGURE 8 | Population Health Informatics Surveillance System.

the public. Increasing usage of mobile phones can facilitate digital interventions to gather and deploy uniform information to ~1.3 billion citizens. Using digital platforms will subjugate data management and health information systems in a close knit manner. By using datasets from around the world, this paper analyzed how the total number of COVID-19 cases and the number of active, recovered, and deceased cases grew, and inferences were made on the impact of the pandemic in India. Daily spikes are credited to human psychology along with outcomes of the lockdown in varying sociocultural settings. From this study, we can suggest that governments of densely populated developing countries such as India implement changes to policies and lockdown guidelines based on the nature of the outbreak in various regions and focus on preparedness. It is important to formulate tools for better district-level planning and prioritization as well as effective allocation of resources (40). Foreseen challenges related to the surveillance system proposed here mainly include the availability of publicly available COVID-19 data in a timely manner, the reporting of cases and deaths related to COVID-19 usually done in an routinely manner, and the lack of availability of advisory and policy data in response to COVID-19 in a homogeneous manner. These limitations

FIGURE 9 | Framework to support decision making for future pandemic preparedness.
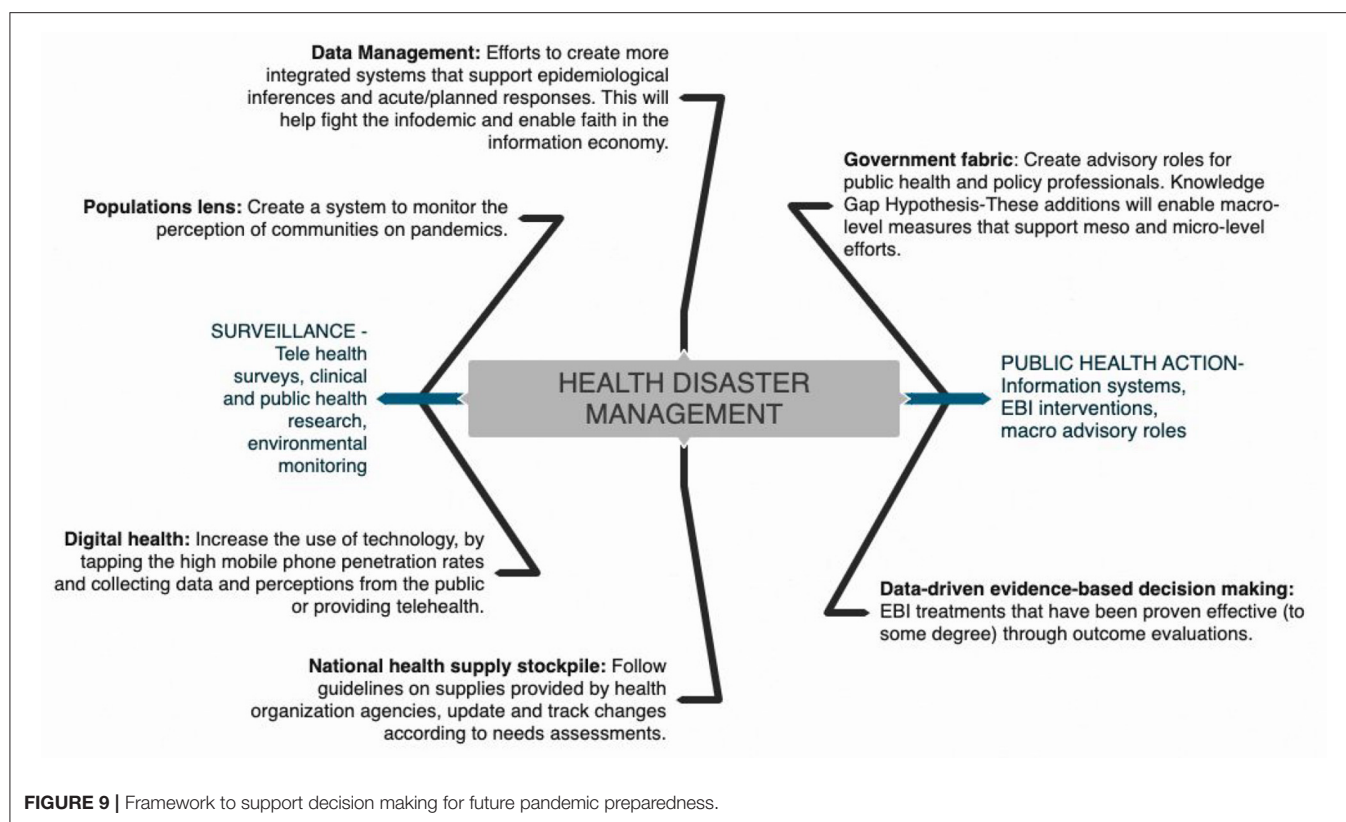
stand for countries like Vietnam, Pakistan, and India and might possibly obstruct surveillance.

Additionally, the "information economy" has contributed to confusion and panic surrounding COVID-19, with instances of unreliable news reports, glitches in filtering, flagging of information that is valid, and world leaders diminishing the coronavirus crisis. Recent research of existing websites disseminating information about the pandemic indicates that current studies are important as they show critical gaps in the information about COVID-19. But it warns that "there is a lack of good quality websites with useful and quality novel coronavirus-related health information" (45). The coronavirus pandemic is a new social phenomenon too, which demands a need for better communication of clear authoritative information. According to Alang (2020), "The nuanced differences between social distancing, self-isolation and quarantining, for example, all need to be communicated to and learned by society at large" (45). Unfortunately, many popular media channels in India seem to go against this grain. Citizens in India require accurate information, with cross-section collaborations used to monitor and filter false information (46) during a public health emergency.

LIMITATIONS AND CONCLUSION

We understand that correlation does not necessarily translate to causation. However, we are able to offer concrete theories of possible associations between variables—protests impacting the incidence of COVID-19 and period prevalence rates

or laboratory testing numbers indicating higher incidence. Additionally, we also have reservations about publicly available testing data in India. Expensive or unreliable tests, slow turnaround time, and poor efficiency of testing raises questions about the veracity of public data. Information on real-time state-wise testing, hospitalizations, state-wise availability of beds, and supplies available to each state were also not accessible. This commentary also acknowledges the slow spread of this epidemic in India but provides little insight into this epidemiologic curiosity, however, a deeper understanding of this unnatural trend is a possible investigation.

The first pandemic declared by the WHO in the 21st century has offered us a singular learning opportunity. We are at a unique crossroads with a new world of social media and quickly evolving generations. It is important to understand how this sort of population responds to stimuli—in this case a global pandemic caused by a highly contagious virus. Current literature has not yet addressed how social media affects the pandemic in India. Is it a boon or a bane? It would also be interesting to study the links between India's young median age and the country's recovery rate. These research opportunities will help us build greater preparedness for any such future health impacts. At this moment, ongoing reforms toward structural economic policy in India and other such settings must continue. A robust urban employment scheme to support the vulnerable populations is seen as an essential next effort. Microeconomic policies to ameliorate the distress caused by the pandemic along with human rights should guide the COVID-19 responses of the devolution.

Equality and non-discrimination are principles to create rightful support opportunities for vulnerable groups.

AUTHOR CONTRIBUTIONS

AJ conceptualized the research paper and contributed to manuscript writing. AM contributed to drafting the paper, manuscript writing, data analysis and interpretation, and critical editing. SA contributed to data gathering. AG contributed to manuscript writing and providing feedback. All authors contributed to the article and approved the submitted version.

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Hesitation and Refusal Factors in Individuals' Decision-Making Processes Regarding a Coronavirus Disease 2019 Vaccination

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Introduction: Considering the global prevalence of coronavirus disease 2019 (COVID-19), a vaccine is being developed to control the disease as a complementary solution to hygiene measures—and better, in social terms, than social distancing. Given that a vaccine will eventually be produced, information will be needed to support a potential campaign to promote vaccination.

Objective: The aim of this study was to determine the variables affecting the likelihood of refusal and indecision toward a vaccine against COVID-19 and to determine the acceptance of the vaccine for different scenarios of effectiveness and side effects.

Materials and Methods: A multinomial logistic regression method based on the Health Belief Model was used to estimate the current methodology, using data obtained by an online anonymous survey of 370 respondents in Chile.

Results: The results indicate that 49% of respondents were willing to be vaccinated, with 28% undecided or 77% of individuals who would potentially be willing to be inoculated. The main variables that explained the probability of rejection or indecision were associated with the severity of COVID-19, such as, the side effects and effectiveness of the vaccine; perceived benefits, including immunity, decreased fear of contagion, and the protection of oneself and the environment; action signals, such as, responses from ones' family and the government, available information, and specialists' recommendations; and susceptibility, including the contagion rate per 1,000 inhabitants and relatives with COVID-19, among others. Our analysis of hypothetical vaccine scenarios revealed that individuals preferred less risky vaccines in terms of fewer side effects, rather than effectiveness. Additionally, the variables that explained the indecision toward or rejection of a potential COVID-19 vaccine could be used in designing public health policies.

Conclusions: We discovered that it is necessary to formulate specific, differentiated vaccination-promotion strategies for the anti-vaccine and undecided groups based on the factors that explain the probability of individuals refusing or expressing hesitation toward vaccination.

Keywords: perceived benefit, health promotion, treatment refusal, health policy, vaccine, Chile

INTRODUCTION

The pandemic—derived from the coronavirus disease 2019 (hereafter, "COVID-19") and characterized by a severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection—has had global effects. Furthermore, it has impacted people's lives, physical and mental health, and economic situation (1–3). Studies indicated that individuals were willing to pay up to $290 for a COVID-19 vaccine, while 10 to 20% would refuse to pay for a vaccine altogether (4, 5). Some governments, such as Australia's, already have announced that a COVID-19 vaccine will be available at no cost, while other countries anticipate that it will be affordable by a majority of people; despite this, uncertainty still exists regarding its effectiveness and side effects in the medium and long term.

Currently, there are several vaccines against COVID-19 that can be manufactured and marketed. During December 2020, several obtained emergency approvals from different health agencies, for example, Moderna in the United States, Pfizer-Biontech in the United States and in Europe, Osford-AstraZeneca in the United Kingdom, and Sinopharm in China. Other vaccines, such as, Sputnik V from Russia, are in phase III and have not yet received approval from the European Medicines Agency (EMA). However, once the vaccine is available, it is important to determine the motivations and health beliefs that will contribute to the decision to be vaccinated and herd immunity can be achieved. By knowing the health beliefs that promote vaccination acceptance, appropriate target campaigns that promote vaccination can be formulated.

According to Jones et al. (6), messages will generate optimal behavioral changes if they affect perceived barriers, benefits, self-efficacy, and threats to achieve broader vaccine acceptance. This should be considered by different governments to implement a vaccination program to combat COVID-19 (7), because, as indicated by Henderson et al. (8) and Ward et al. (9), trust in public health measures and governments influences the willingness to adopt preventive measures. Further, special consideration must be given not only to the anti-vaccine movement and perceptions of a vaccine conspiracy as presented on social media (10, 11) but also to the possible mistrust of institutions or governments regarding vaccinations (12). This is critical when governments attempt to control a pandemic, as a population's hesitancy can soon become a refusal, as mentioned by academics (13). Consequently, this can limit the related public policy's effectiveness, which should be based on knowledge, trust, and legitimacy (12). The roles of social media and physicians in this process could become crucial given their relevance in generating public concerns and influence.

Studies have applied different models trying to explain the willingness-to-pay as well as vaccine acceptance, hesitancy, and refusal to vaccinate, which can vary depending on the context of the individuals and epidemiological conditions of the country. Some researchers have analyzed the variables and factors that explain the probability of getting vaccinated, including individual perceptions and preferences and motivations that affect people's actions (14). Similarly, others have considered that vaccination decisions are also influenced by the individual and group context, and the characteristics of the vaccine (15–17).

As the determinants of vaccine preferences and hesitancy vary across time, place, and vaccines (18), the current situation requires information regarding the determinants that affect people's probability of being vaccinated against COVID-19, as well as the perceived benefits, barriers, threats, and action cues to define the appropriate policies and communication campaign to increase the likelihood of people engaging in health-promoting behavior or, specifically, being vaccinated. In this context, the most appropriate model is the Health Belief Model (HBM). It has been demonstrated that the variable or factor path is not completely defined for this type of model (6). As such, different path relationships can be assumed among variables; that is, the functional form of the HBM is flexible. Therefore, we assumed that there would be a direct relationship between vaccination and the explanatory variables of the HBM. In terms of public policy, the HBM reveals that the variables to be considered relate to perceived barriers, benefits, susceptibility, severity, and cues of actions, among others; in this vein, scarce literature exists regarding the COVID-19 vaccine (5, 19).

Therefore, this study aimed to identify the refusal and hesitancy factors in accepting a hypothetical COVID-19 vaccination in Chile, based on the HBM and using a multinomial logistic regression model (14, 20, 21). This is relevant because the government will need to define the beliefs and variables that should be pursued in communication campaigns to incentivize potential vaccine acceptance (22). This study also provides important information about potential vaccine preferences under three safety and effectiveness scenarios, as well as the main reason to refuse a vaccination. It should be noted that the baseline scenario is the same as the results of the clinical trials (phase III development) of the Pfizer and BioNTech vaccines. Additionally, our study differs from others conducted in the COVID-19 context (5, 19), in that we consider not only the traditional variables from the HBM but also the motivations and cues to action variables (associated with conspiracy theories, the government's communication response, the influence of the family, trusted doctors, and health authorities, which could affect the decision to get vaccinated). By doing so, this study addresses the multiplicity of factors that could influence vaccination decisions (17) and reduces the statistical bias due to the omission of any relevant variables (23).

MATERIALS AND METHODS

Study Design

This was a cross-sectional study. As COVID-19 vaccines will soon be largely available, we framed the study questions around a hypothetical vaccine. First, we evaluated the intention to vaccinate for different effectiveness scenarios and side effects. Second, we identified the determinants of refusal and hesitancy through a multinomial model based on a health beliefs approach similar to previous studies (19, 24). However,

we considered complementary explanatory variables that could influence a communication strategy for a vaccination campaign against COVID-19.

Setting and Period

Given the pandemic and some movement restrictions or quarantines in Chile, this research data were obtained from a self-applied online questionnaire available to respondents 18 years or older through social media, between August 19 and September 13, 2020.

Sample Size and Recruitment

We reached our population objective by using an online mixed sampling process—including snowball and convenience sampling—but under an active recruitment system. This allowed for an improved, more representative sample population, with a total of 370 respondents, assuming a maximum variance, infinite population, a confidence level of 95%, and a margin error of 5.09, considering the simple random sampling.

Measurement and Data Collection Techniques

The questionnaire contained four main sections on the COVID-19 situation, beliefs, threats, perception about contracting the illness, and reasons for vaccination, specifically, (a) four questions on susceptibility, three on severity, two on barriers, four on benefits, six on action cues, and two on motivation-related aspects; (b) three questions about the disposition toward vaccination (with 95% regarding effectiveness, 50% regarding effectiveness and minor side effects, and 95% effectivity with unknown side effects), with three possible answers (yes, no, and undecided); (c) a question about the respondent's preferred vaccine developer or producer; (d) reasons for refusal, hesitancy, and dilation to be vaccinated (12 questions); and (e) the respondents' sociodemographic background (eight questions). Most questions were scored on a scale ranging from one ("completely disagree" or "very low" = 1) to five ("completely agree" or "very high" = 5). Additionally, nine questions in section (a) required "yes" or "no" answers, while the questions in sections (b) and (c) were answered as "yes," "no," or "hesitancy (undecided)" for each of the previously mentioned alternatives. The scale reliability based on the Cronbach alpha coefficient was 0.757, which is appropriate.

Ethical Considerations

This study received an exemption status: anonymous and non-sensitive survey research. Before the respondent could access the questionnaire, they were required to give informed consent to participate in the study. They were also informed that the questionnaire was anonymous and voluntary, and respondents' personal information and responses will not be disclosed. Furthermore, they were told the data will be used in aggregated terms.

Data Analysis

Acceptance, Hesitation, and Rejection of a Vaccine Against Coronavirus Disease 2019

We first created scenarios involving three vaccine types, as follows: "Today, would you be willing to receive a free vaccine against COVID-19 that is 95% effective?" (Scenario 1), "Today, would you be willing to receive a free 50% effective vaccine against COVID-19 that will have minor side effects, such as headache, fatigue, muscle aches, pain and rash?" (Scenario 2), and "Today, are you willing to get a free vaccine against COVID-19 with 95% effectiveness, but with unknown side effects?" (Scenario 3). A descriptive statistical analysis was performed of these scenarios, with difference tests on the mean for the different vaccine acceptance rates, and an analysis of the reasons for refusing vaccination.

Adapted Health Belief Model

As a theoretical frame of reference, we considered the belief model that has been widely applied to different diseases (5, 19, 24). However, we differed from the available literature by estimating a multinomial model that allowed us to measure the probabilities of individuals' decisions regarding vaccination, remaining undecided, or refusing vaccination entirely. Thus, our estimation method assumes a direct relationship between the variables that make up the HBM factors and the predictor or dependent variable (accepting the vaccine, rejecting it, or expressing indecision). In our case, various factors were considered—or specifically, susceptibility, severity, benefits, barriers, motivations, action cues, and sociodemographic control variables as explanatory variables—to identify the main aspects that influence the decision to vaccinate against COVID-19. For this, the dependent variable (y_i) of the result was the following:

$$y_i = \begin{cases} 0 \text{ would be vaccinated} \\ 1 \text{ Would not be vaccinated} \\ 2 \text{ Undecided} \end{cases}$$

Specifically, based on Champion and Skinner (25), *perceived benefits* were beliefs in the efficacy of the advised action to reduce the risk or seriousness of the impact of COVID-19, *perceived barriers* were beliefs of the tangible and psychological that limit the decision to get vaccinated, *severity* was opinions of how COVID-19 is considered a serious condition and what its consequences are, *perceived susceptibility* was opinions on the chances of experiencing a risk or getting COVID-19, and *cues to action* were strategies to activate readiness or precipitating forces that make a person feel the need to get vaccinated.

It is highlighted in the literature that studies using the HBM to determine the factors that influence the decision to vaccinate or pay are relatively scarce. Jones et al. (6) considered four factors with 25 variables and five relevant controls of the HBM to evaluate the success of the vaccination campaign against H1N1, while Wong et al. (5) studied five factors with 15 variables and another 10 as control variables to determine the willingness to receive and pay for a vaccine against COVID-19. Both considered perceived benefits, perceived barriers, severity, and perceived susceptibility; and control variables as relevant factors. They

differed in that while Jones et al. (6) included self-efficacy, Wong et al. (5) considered cues to action.

It is relevant to understand that signals are the ones that motivate or discourage the action of getting vaccinated. Therefore, we considered six factors, previously defined, with 29 variables including control variables based on previous literature about the HBM. For example, we added other relevant variables such as susceptibility of the infection rate per 1,000 inhabitants, the barrier about anti-vaccine communications on social media, the motivation associated with that the disease was invented by politicians and the pharmaceutical industry, and the cues to action about the government's communication in response and experts recommending the vaccine.

With these variables, we estimated a multinomial logistic regression model in which the dependent variable was categorically unordered with three levels regarding the individual's disposition toward vaccination, defined as "yes," "no," or "undecided." This was estimated under the maximum likelihood estimation method, which is appropriate considering that it does not require the independent variables (which make up the HBM factors) to be statistically independent; that is, it does not contradict the fact that there could be mediating variables, according to what was indicated by Jones et al. (6). The variables were selected using a stepwise statistical procedure and performed using Stata 16 data analysis and statistics software. It should be noted that we report the statistical analysis of the model only for the baseline scenario (Scenario 1: 95% effective vaccine), which provides enough information to formulate public health policies and obtain the best goodness of fit, among the estimates under the three options or individual election (refusal/reject, accept, or hesitancy about the vaccine). Additionally, the model was validated with the analysis of the goodness of fit through the maximum likelihood criterion, Wald's statistic, and multicollinearity test, among others.

Subsequently, the determinants (explanatory variables associated with the HBM factors) of the probability of refusal and hesitancy were analyzed, considering its statistical significance (p-value < 0.05). Specifically, the coefficients of the estimation of the multinomial logit model were analyzed; in this, the coefficients (Coef.) were interpreted as the change in one unit in the explanatory variable, and how much variation is generated in the logarithmic probabilities relative to rejecting the vaccine against being vaccinated, given that the variables in the model are held constant. The relative risk ratios (RRR) indicate the expected risk of not getting vaccinated compared with doing so, understanding risk relative to probability (26). These were analyzed in a similar way, but for hesitancy regarding being vaccinated.

RESULTS

Data Description

Table 1 presents the general demographic variables under the three vaccine scenarios. The respondents' main demographic data were as follows: 58% were female, 74% had a university degree, 45% had public health care, 5% had no health care, 40% had a relative or friend working in the health-care

industry, and 11% were working in health care. The respondents' age categories were homogeneous in three central values, with ~22% representation but extreme, lower values (12 and 17%, the youngest and oldest respondents, respectively). The socioeconomic status of the respondents was primarily middle- and high-income levels, with a frequency of 70% (comparable with the national population of 68%) (27). Additionally, 51% had experienced increased fear of infection in the last 3 months before the survey was conducted.

A comparison by gender indicates that men had a greater rate of acceptance for the vaccine than women (57 vs. 44%, as a proportion within each category by gender), while women had a higher rate of refusal and undecided responses. Our test of means revealed that the differences in the response rates in the baseline scenario were statistically significant, with a Pearson's chi-squared (2) = 6.23; Pr = 0.044. Additionally, we did not find statistically significant differences by income, education, or health insurance system.

Preference for a Hypothetical Vaccination Against Coronavirus Disease 2019 Under Three Vaccine Scenarios

We defined three scenarios to observe the hypothetical preference for a vaccine, the results of which are presented in **Figure 1**. In Scenario 1, we observed that ~49% of the respondents were willing to be vaccinated and 28% were undecided, indicating 77% were potentially willing to be vaccinated. These percentages change significantly if the side effects are unknown (Scenario 3), decreasing respondents' willingness to be vaccinated to 28% and increasing rejection from 23 to 44%. The percentage of undecided respondents was quite similar among the three scenarios.

Additionally, the age composition for acceptance, rejection, or indecision regarding the vaccine changed according to the vaccination scenarios (**Table 1**). Comparing both cases relative to the baseline revealed that indecision decreased in favor of rejection at 95% effectiveness but with unknown side effects, while indecision in favor of rejection decreased at 50% effectiveness but with minor side effects. Furthermore, the increase in the rejection rate was greater in Scenario 3 (57%) than in Scenario 2 (6%).

Reasons Why Respondents Avoid Vaccination

All those who responded to the survey were asked to mention the main reason that could lead them to avoid vaccination. The first-ranked reason was the vaccine's side effects and extent of risk, which is consistent with the information presented in the previous section. The second-ranked reason was the lack of knowledge of the vaccines, and the third-ranked reason was that they would prefer others to be vaccinated first (**Figure 2**).

Additionally, we show the refusal to vaccinate rate disaggregated by age range, gender, and education level (**Table 2**). The age category indicates that respondents between ages 30 and 49 considered their concerns with a vaccine's side effects and risks as the main reason for rejection. The

TABLE 1 | Sociodemographic data for three scenarios regarding a hypothetical vaccine against COVID-19.

Variable	n (%)	Willingness to vaccinate, 95% effectiveness (baseline) n (%)			Willingness to vaccinate, 50% effectiveness; minor side effects n (%)			Willingness to vaccinate, 95% effectiveness; unknown side effects n (%)		
		No	Undecided	Yes	No	Undecided	Yes	No	Undecided	Yes
Age										
18–29	45 (12)	11 (24)	16 (36)	18 (40)	19 (42)	12 (27)	14 (31)	28 (62)	8 (18)	9 (20)
30–39	88 (24)	19 (22)	25 (28)	44 (50)	26 (30)	20 (22)	42 (48)	30 (34)	35 (40)	23 (26)
40–49	82 (22)	24 (29)	20 (25)	38 (46)	40 (49)	15 (18)	27 (33)	45 (55)	17 (21)	20 (24)
50–59	80 (21)	11 (14)	24 (30)	45 (56)	27 (34)	23 (29)	30 (37)	34 (43)	22 (27)	24 (30)
60+	62 (17)	16 (26)	15 (24)	31 (50)	25 (40)	19 (31)	18 (29)	19 (31)	15 (24)	28 (45)
Gender										
Female	216 (58)	55 (65)	66 (65)	95 (52)	85 (60)	56 (40)	75 (56)	103 (64)	62 (60)	51 (49)
Male	150 (41)	28 (33)	36 (35)	86 (47)	55 (39)	38 (59)	57 (43)	56 (35)	41 (40)	53 (50)
Not defined	4 (1)	2 (2)	0	2 (1)	1 (1)	1 (1)	2 (1)	3 (2)	0	1 (1)
Education										
High school	38 (10)	5 (6)	12 (12)	21 (12)	9 (6)	12 (13)	27 (13)	18 (11)	7 (7)	13 (12)
Technical	57 (15)	15 (18)	18 (18)	24 (13)	25 (18)	17 (18)	15 (11)	29 (18)	16 (15)	12 (11)
University degree	140 (38)	34 (40)	42 (41)	64 (35)	50 (36)	36 (38)	54 (40)	62 (8)	39 (38)	39 (37)
Graduate degree	135 (36)	31 (36)	30 (29)	74 (40)	57 (40)	30 (31)	48 (46)	53 (33)	41 (40)	41 (40)
Monthly income										
Less than $569	53 (14)	9 (11)	14 (14)	30 (16)	12 (9)	18 (19)	23 (17)	20 (12)	15 (15)	18 (17)
$570–$953	57 (15)	15 (18)	17 (17)	25 (14)	21 (15)	18 (19)	18 (13)	29 (18)	15 (15)	13 (12)
$954–$1,476	53 (14)	13 (15)	12 (12)	28 (15)	21 (15)	13 (14)	19 (14)	20 (12)	16 (15)	17 (16)
$1,477–$2,186	63 (17)	10 (12)	16 (16)	37 (20)	26 (18)	16 (17)	21 (16)	26 (16)	15 (14)	22 (21)
$2,186+	144 (39)	38 (45)	43 (42)	63 (34)	61 (43)	30 (31)	53 (40)	67 (41)	42 (41)	35 (33)
Type of health system										
None	17 (5)	4 (5)	3 (3)	10 (5)	6 (4)	6 (6)	5 (4)	5 (3)	8 (8)	4 (4)
Public	158 (43)	36 (43)	41 (41)	81 (22)	55 (39)	39 (41)	64 (48)	76 (47)	33 (32)	49 (46)
Private	192 (52)	45 (52)	58 (56)	89 (49)	80 (57)	49 (52)	63 (47)	81 (50)	59 (57)	52 (50)
Other	3 (1)	0	0	3 (2)	0	1 (1)	2 (1)	0	3 (3)	0
Relative work health system										
No	223 (60)	45 (53)	70 (69)	108 (59)	79 (56)	60 (63)	84 (63)	99 (61)	62 (60)	62 (59)
Yes	147 (40)	40 (47)	32 (31)	75 (41)	62 (44)	35 (37)	50 (37)	63 (39)	41 (40)	43 (41)
Work health system										
No	328 (89)	73 (86)	98 (96)	157 (86)	122 (87)	6 (1)	120 (90)	147 (91)	92 (89)	89 (85)
Yes	42 (11)	12 (14)	4 (4)	26 (14)	19 (13)	9 (9)	14 (10)	15 (9)	11 (11)	16 (15)
Fears of infection have increased in the last 3 months										
No	180 (49)	48 (55)	51 (50)	81 (44)	78 (55)	42 (44)	60 (45)	82 (51)	48 (47)	50 (48)
Yes	190 (51)	37 (45)	51 (50)	102 (56)	63 (45)	53 (56)	74 (55)	80 (49)	55 (53)	74 (55)

COVID-19, coronavirus disease 2019.

other respondents distributed their preferences among all the alternatives, with percentages fewer than 10%. Similarly, the refusal rate by level of education shows that more educated people rejected the vaccine more often because of risks and side effects (graduated: 17%; university degree: 13%) than people with lower levels of education (high school: 2.7%). Likewise, those with a higher level of education showed a higher rejection rate due to a lack of knowledge of the vaccine (university degree 11%) than people who had a high school education (3%). Women rejected the vaccine more than men, mainly because of concern about side effects (women: 26.2% vs. men: 13.8%) and because

of a lack of knowledge about the vaccine (women: 11.9% vs. men: 11.3%).

Adapted Health Belief Model

Table 3 presents the main variables and their definition as included in the adapted HBM. The frequency statistics indicate that the main beliefs that led individuals to vaccinate were the perceived benefit of protecting themselves and their families (90% strongly agree or agree), the action cues regarding the responses of their families during the pandemic (85% strongly agree or agree), the severity of complications from
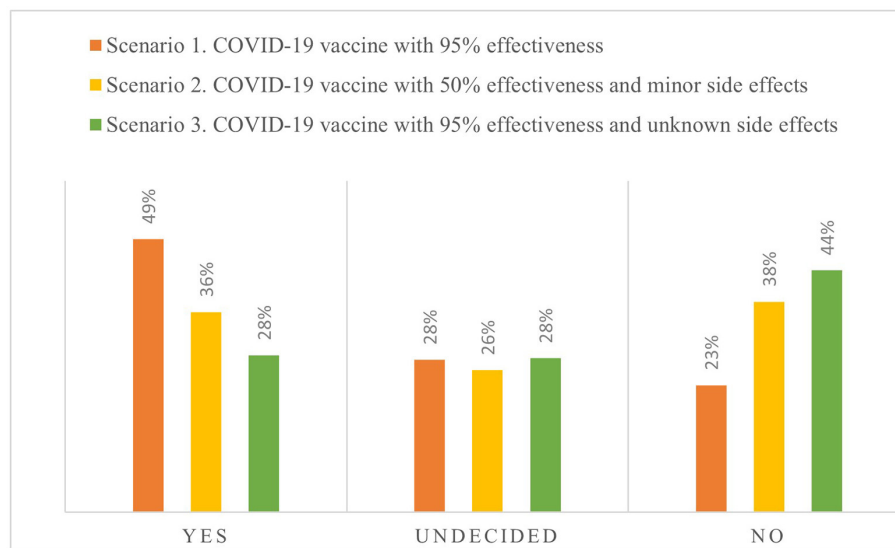
FIGURE 1 | Preferences for a hypothetical vaccine against coronavirus disease 2019 (COVID-19) under three options.
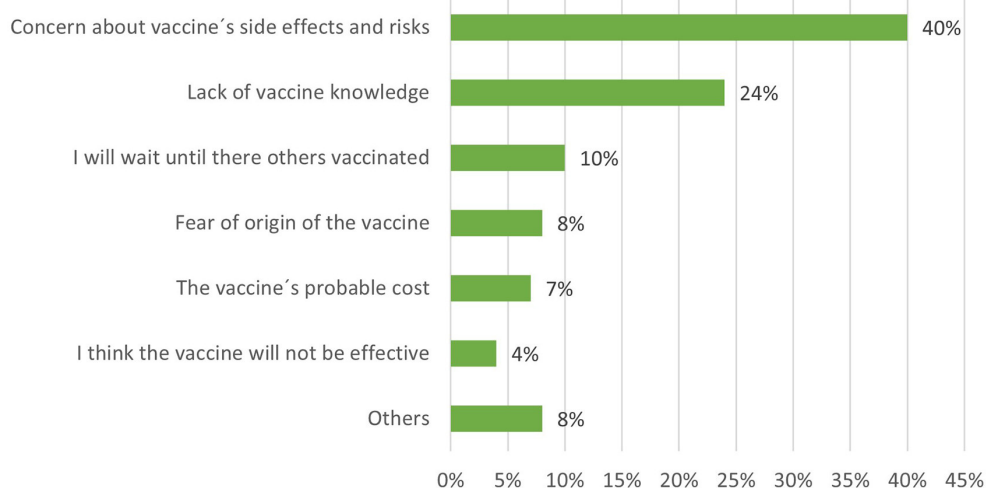
FIGURE 2 | Reasons why respondents may avoid vaccination.

contracting COVID-19 (71% strongly agree or agree), and the benefit associated with the fact that the vaccine would reduce the fear of getting infected (70% strongly agree or agree) in considering a potential immunity against the disease.

Additionally, the results from the descriptive statistics are consistent with respondents' preferences for the scenarios, as the former demonstrate that people cared more about the potential risks from vaccination than its effectiveness. In other words, individuals perceived or preferred aspects associated with safety and fewer side effects over the vaccine's effectiveness. Specifically, the vaccine's health risks were a relevant barrier for a relatively high number of respondents (66% strongly agree or agree), while

the perceived benefits from having an available, effective vaccine were slightly fewer (56% strongly agree or agree).

Another noteworthy aspect is the barrier associated with social media's potential negative influence on the decision to be vaccinated, where respondents significantly disagreed and strongly disagreed (46%); additionally, 30% were indifferent (**Table 3**). Regarding the frequency of responses by severity, the results indicate that the factors that could potentially influence the vaccination decision included whether the respondent had a family member with a chronic disease and the country's infection rate.

Table 4 displays the estimation results from the multinomial logit regression model, which indicate that the model containing

TABLE 2 | Reasons why respondents may avoid vaccination by gender, age, and education (percentage of frequencies).

	Concern about vaccine's side effect and risks	Lack of vaccine knowledge	I will wait until there others vaccinated	Fear of origin of the vaccine	The vaccine's probable cost	I think the vaccine will not be effective	Others	Total
Gender								
Female	26.22	11.89	6.76	4.59	4.32	1.08	3.51	58.38
Male	13.78	11.35	3.24	3.24	2.43	2.70	3.78	40.54
Not defined	0.27	0.27	0.00	0.00	0.00	0.27	0.27	1.08
Total								100
Age								
18–29	5.68	2.97	1.89	0.27	0.00	0.27	1.35	12.16
30–39	12.97	4.05	2.16	1.08	1.62	0.81	1.08	23.78
40–49	10.00	5.41	2.16	0.81	1.89	0.81	1.08	22.16
50–59	6.76	6.49	1.35	1.89	1.62	1.62	1.89	21.62
60+	4.86	4.59	2.43	3.78	1.62	0.81	2.16	20.27
Total								100
Education								
High school	2.70	2.97	0.81	0.81	1.35	0.00	1.62	10.27
Technical	7.30	3.24	2.70	0.81	0.54	0.00	0.81	15.41
University degree	13.24	11.35	3.51	2.16	2.70	1.89	2.97	37.84
Graduate degree	17.03	5.95	2.97	4.05	2.16	2.16	2.16	36.49
Total								100

the full set of predictors represents a significant improvement in fit relative to a null model (logit regression chi-squared $p < 0.001$); therefore, it can be inferred that at least one population slope is non-zero. Hausman's test demonstrated that the answers exist independent of other alternatives. According to McFadden's pseudo R-squared value, we can conclude that the full model containing our predictors represents a 37% improvement in fit relative to the model; and the mean of the variance inflation factor (VIF) was 1.92, indicating that there was no collinearity. Thus, the model had sufficient statistical validity.

In estimating the model, we assigned the "Yes, I will be vaccinated" category as a baseline, with no coefficients or test provided in this category. Therefore, we interpreted the coefficients' values by comparing the baseline relative with the "No, I refuse to be vaccinated" and "I have not yet decided whether to vaccinate (undecided)" categories. Taking the "Yes, I will be vaccinated" response as a baseline is convenient, as this permits us to analyze the independent variables that significantly predict whether a respondent falls into the baseline or comparison category. In other words, we could then observe the variables that significantly predict whether a respondent was anti-vaccine or undecided instead of pro-vaccine. Subsequently, we could identify the independent variables relevant in creating potential public policies for these vaccinations.

Determinants of the Probability of Hesitancy

We considered the coefficients of the multinomial logit estimate that were statistically significant to identify the positive and negative determinants of the probability of hesitancy (**Table 4**).

On the one hand, the variables that reduced the logarithmic relative probability of hesitancy versus being vaccinated against COVID-19 were the increased availability of an effective vaccine (Coef.: −1.71; 99%), work in the health sector (Coef.: −1.34; 99%), the increase in the contagion rate per 1,000 inhabitants (Coef.: −0.77; 95%), the social network indicating that vaccinating is inconvenient and increased belief that the vaccine reduces fear of contagion (Coef.: −0.56; 99%), and the greater the perceptions of health complications generated by COVID-19 (Coef.: −0.38; 95%). On the other hand, the main variables that increased this relative probability were increased positive perceptions about the government's communication response to the pandemic (Coef.: 0.64; 99%), the greater fear of side effects (Coef.: 0.53; 95%) and the belief that the vaccine is risky (Coef.: 0.47; 99%), the increase in lack of general knowledge of the vaccine (Coef.: 0.53; 99%), a preference for waiting for others to get vaccinated first (Coef.: 0.44; 99%), and the level of income (Coef.: 0.25; 95%).

The expected risk of rejection was lower for individuals who had a greater belief in the severity of the complications of contracting COVID-19 (RRR: 0.662; 99%), those who think that the vaccine could protect themselves and their families (RRR: 0.484; 95%), the perception that the available vaccine is effective (RRR: 0.426; 90%), the better the family's response to the pandemic (RRR: 0.631; 95%), and men compared with women (RRR: 0.459; 95%). The probability of rejection compared with the group that would be vaccinated, measured in relative risk, increased mainly with concern about side effects (RRR: 2.33; 99%), the belief that the vaccine will not be effective (RRR: 1.54; 95%) or that it will be very risky (RRR: 1.59; 95%), and level of income (RRR: 1.44; 95%).

TABLE 3 | Health belief adapted model variable definition and vaccination preference.

	Strongly disagree/not probable	Disagree/somewhat improbable	Neither agreement nor disagree/neutral	Agree/somewhat probable	Strongly agree/very probable
Barrier 1. Social networks indicate that vaccinating is inconvenient					
Total	142 (38)	68 (18)	110 (30)	28 (8)	22 (6)
Not	27 (32)	17 (20)	28 (33)	8 (9)	5 (6)
Undecided	34 (33)	19 (19)	38 (37)	6 (6)	5 (5)
Yes	81 (44)	32 (17)	44 (24)	14 (8)	12 (7)
Barrier 2. I think the vaccine will be very risky					
Total	12 (3)	20 (5)	107 (29)	113 (31)	118 (32)
Not	3 (4)	3 (4)	26 (31)	23 (27)	30 (35)
Undecided		3 (3)	31 (30)	31 (30)	37 (36)
Yes	9 (5)	14 (8)	50 (27)	59 (32)	51 (28)
Severity 1. I consider the severity of complications from contracting COVID-19					
Total	8 (2)	24 (6)	75 (20)	106 (29)	157 (42)
Not	4 (5)	9 (11)	23 (27)	21 (25)	28 (33)
Undecided	1 (1)	6 (6)	23 (23)	28 (27)	44 (43)
Yes	3 (2)	9 (5)	29 (16)	57 (31)	85 (46)
Severity 2. I think the vaccine will be ineffective					
Total	52 (14)	108 (29)	121 (33)	55 (15)	34 (9)
Not	4 (5)	19 (22)	23 (27)	24 (28)	15 (18)
Undecided	7 (7)	19 (22)	23 (27)	24 (28)	15 (18)
Yes	41 (22)	62 (34)	48 (26)	19 (10)	13 (7)
Severity 3. I have concerns regarding the side effects					
Total	22 (6)	37 (10)	112 (30)	93 (25)	106 (29)
Not	2 (2)	4 (5)	16 (19)	21 (25)	42 (49)
Undecided	1 (1)	4 (4)	29 (28)	37 (36)	31 (30)
Yes	19 (10)	29 (16)	67 (37)	35 (19)	33 (18)
Motivation 1. Religious reasons					
Total	229 (62)	60 (16)	67 (18)	7 (2)	7 (2)
Not	54 (64)	16 (19)	12 (14)	2 (2)	1 (1)
Undecided	60 (59)	17 (17)	24 (23)	1 (1)	
Yes	115 (63)	27 (15)	31 (17)	4 (2)	6 (3)
Motivation 2. The disease was invented by politicians and the pharmaceutical industry					
Total	212 (57)	54 (15)	70 (19)	18 (5)	16 (4)
Not	41 (48)	11 (13)	21 (25)	2 (2)	10 (12)
Undecided	57 (56)	19 (19)	19 (19)	4 (4)	3 (3)
Yes	114 (62)	24 (13)	30 (16)	12 (7)	3 (2)
Benefit 1. I would protect myself and my family					
Total	10 (3)	5 (1)	23 (6)	54 (15)	278 (75)
Not	8 (9)	5 (6)	15 (18)	17 (20)	40 (47)
Undecided	-	–	7 (7)	20 (20)	75 (73)
Yes	2 (1)	–	1 (1)	17 (9)	163 (89)
Benefit 2. The vaccine will reduce my fear of contagion					
Total	22 (6)	20 (5)	68 (18)	123 (33)	137 (37)
Not	14 (16)	11 (13)	28 (33)	21 (25)	11 (13)
Undecided	–	8 (8)	22 (22)	46 (45)	26 (25)
Yes	8 (4)	1 (0.5)	18 (10)	56 (31)	100 (55)
Benefit 3. The available vaccine is effective					
Total	14 (4)	12 (3)	127 (37)	103 (28)	104 (28)
Not	11 (13)	6 (7)	40 (47)	10 (12)	18 (21)
Undecided	2 (2)	3 (3)	50 (49)	32 (31)	15 (15)
Yes	1	3 (2)	47 (26)	61 (33)	71 (39)

(Continued)

TABLE 3 | Continued

	Strongly disagree/not probable	Disagree/somewhat improbable	Neither agreement nor disagree/neutral	Agree/somewhat probable	Strongly agree/very probable
Benefit 4. The available vaccine is safe					
Total	17 (5)	12 (3)	139 (37)	95 (26)	107 (29)
Not	12 (14)	6 (7)	39 (46)	8 (9)	20 (24)
Undecided	2 (2)	3 (3)	49 (48)	31 (30)	17 (17)
Yes	3 (2)	3 (2)	51 (28)	56 (31)	70 (38)
Cue_to_action 1. I will wait for others to be vaccinated					
Total	63 (17)	40 (11)	97 (26)	98 (26)	72 (19)
Not	9 (11)	11 (13)	25 (29)	16 (19)	24 (28)
Undecided	5 (5)	5 (5)	26 (25)	42 (41)	24 (24)
Yes	49 (27)	24 (13)	46 (25)	40 (22)	24 (13)
Cue_to_action 2. A lack of vaccine knowledge					
Total	69 (19)	38 (10)	68 (18)	98 (26)	97 (26)
Not	14 (16)	11 (13)	10 (12)	22 (26)	28 (33)
Undecided	6 (6)	5 (5)	18 (18)	39 (38)	34 (33)
Yes	49 (27)	22 (12)	40 (22)	37 (20)	35 (19)
Cue_to_action 3. The government's communication in response					
Total	78 (21)	85 (23)	112 (30)	80 (22)	15 (4)
Not	31 (36)	20 (24)	19 (22)	13 (15)	2 (2)
Undecided	19 (19)	18 (18)	41 (40)	19 (19)	5 (5)
Yes	28 (15)	47 (25)	52 (28)	48 (26)	8 (4)
Cue_to_action 4. Family's response to the pandemic					
Total	2 (2)	15 (4)	39 (11)	154 (42)	160 (43)
Not	2 (2)	6 (7)	12 (14)	33 (39)	32 (38)
Undecided	-	1 (1)	15 (15)	41 (40)	45 (44)
Yes		8 (4)	12 (7)	80 (44)	83 (45)
Cue_to_action 5. The Medical College of Chile recommended the vaccine					
	26 (7)	14 (4)	109 (29)	108 (29)	113 (31)
	12 (14)	8 (9)	36 (42)	17 (20)	12 (14)
	2 (2)	3 (3)	26 (25)	44 (43)	27 (26)
	12 (7)	3 (2)	47 (26)	47 (26)	74 (40)
Cue_to_action 6. My doctor recommended the vaccine					
Total	48 (13)	45 (12)	104 (28)	81 (21)	92 (24)
Not	11 (13)	11 (11)	24 (28)	17 (20)	22 (26)
Undecided	14 (14)	11 (11)	30 (29)	24 (24)	23 (23)
Yes	23 (13)	23 (13)	50 (27)	40 (22)	47 (26)
Susceptibility 1. Family with the possibility of contracting COVID-19					
Total	70 (19)	96 (26)	138 (37)	33 (9)	33 (9)
Not	20 (5)	22 (6)	29 (8)	8 (2)	6 (2)
Undecided	13 (4)	31 (9)	37 (10)	11 (3)	10 (3)
Yes	37 (10)	43 (12)	72 (20)	14 (4)	17 (5)
Susceptibility 2. A family member has chronic diseases					
	No	**Yes**			
Total	82 (22)	288 (78)			
Not	17 (20)	68 (80)			
Undecided	21 (21)	81 (79)			
Yes	44 (24)	139 (76)			
Susceptibility 3. Family or relative with COVID-19					
Total	291 (79)	79 (21)			
Not	76 (89)	9 (11)			
Undecided	73 (72)	29 (28)			
Yes	142 (78)	41 (22)			

(Continued)

TABLE 3 | Continued

	Strongly disagree/not probable	Disagree/somewhat improbable	Neither agreement nor disagree/neutral	Agree/somewhat probable	Strongly agree/very probable
Susceptibility 4. Chile has one of the highest infection rates per 1,000 inhabitants					
Total	92 (25)	278 (75)			
Not	24 (28)	61 (72)			
Undecided	34 (33)	68 (67)			
Yes	34 (19)	149 (81)			

COVID-19, coronavirus disease 2019.

Determinants of the Probability of Refusal

The variables that reduced the logarithmic relative probability of refusal versus being vaccinated against COVID-19, considering the estimation coefficients, were increase in family members who have contracted COVID-19 (Coef.: −2.13; 99%), increased availability of an effective vaccine (Coef.: −0.85; 90%), the perception that the vaccine could protect oneself and others (Coef.: −0.72; 95%), increased perceived benefits of the vaccine reducing fear of contagion (Coef.: −0.69; 99%), the family's improved response to the pandemic (Coef.: −0.46; 95%), and an increased perception regarding the severity of the infection caused by SARS-CoV-2 (Coef.: −0.41; 95%). The relative probability of refusal increases while the relative probability of rejection increases with the increase in concern about side effects (Coef.: 0.85; 99%) and risk (Coef.: 0.46; 95%), and the growth of the belief that the vaccine could be ineffective (Coef.: 0.43; 95%), among others that are presented in **Table 4**.

The RRRs indicate that if an individual increases the score in the items that are statistically significant in the model by one point, it would be expected that the relative risk of rejection of the vaccine will decrease in relation to its acceptance, since other variables in the model remain constant. The most relevant items that showed this behavior were consideration of the severity of the complications of becoming infected with SARS-CoV-2 (RRR: 0.67; 95%), the family's response to the pandemic (RRR: 0.63; 95%), the expected benefits of protecting oneself and others (RRR: 0.48; 95%), and family or relatives with COVID-19 (RRR: 0.12; 99%). Additionally, for women in comparison with men, the relative risk of rejection in relation to the acceptance of the vaccine would be expected to decrease by a factor of 0.46 (95%), since the other variables in the model remain constant.

DISCUSSION

Authorities worldwide have addressed the COVID-19 pandemic by promoting preventive measures based on hygiene and social distancing. As the disease continues to expand, nonetheless, it is expected that the next step in this battle involves developing and distributing a vaccine. However, individuals must be willing to be vaccinated to ensure widespread global immunity. In this regard, our results from sampling 370 Chileans revealed that 49% of respondents were willing to be vaccinated, with 28% undecided and 23% refusing vaccination altogether. Overall, these respondents would consider a hypothetical vaccine with

95% efficacy and minor side effects. Thus, we found that 77% of individuals would potentially be vaccinated. This is consistent with other recent findings, in the sense that the undecided group is a more flexible group and with appropriate interventions they are more likely to change from being undecided to acceptance of a vaccine (28).

In addition, the proportions by groups of acceptance, refusal, and hesitancy are similar to those obtained by Lazarus et al. (29) and Wong et al. (5), but lower than those of Harapan et al. (24) who found an acceptance rate of 93.3% for a vaccine with 95% effectiveness. Our work differs from previous studies in that we evaluated how the vaccine's acceptance changes given hypothetical variations in efficacy or side effects under three scenarios. In this regard, we found that more individuals exhibited higher rejection rates for a highly effective vaccine with unknown side effects (44%) than when faced with a less effective vaccine with lesser side effects (38%). This illustrates the importance of not only rigorous human testing of the vaccine but also communicating the vaccine's side effects to society, as this will directly affect individuals' preferences and their vaccination decisions. It should be noted that this contradicts what has been stated in some studies; for example, Dubé et al. (30) indicated that the information on effectiveness and side effects did not affect the people's decision about getting vaccinated.

Although we identified the determinants of hesitation or refusal compared with a group of individuals who were willing to be vaccinated, our study also provides other findings similar to those of Wong et al. (5). Both studies demonstrated that decreasing the fear or concern of getting the illness was a key aspect in determining the vaccination decision; further, this vaccine would help to reduce the possibility of contagion. However, our model exhibits a better goodness of fit and more statistically significant variables that explain the indecision toward or rejection of the vaccine, compared with the one developed by Wong et al. (5). We found that other key belief-related variables that affect the decision not to vaccinate and/or indecision are complications from a SARS-CoV-2 infection; an effective vaccine's availability; fear of the vaccine's side effects and health risks; the disease's prevalence, or rate per 1,000 inhabitants; the roles of social media and government authorities; and the recommendations from health or medical unions. All these variables were statistically significant, with important implications in designing vaccination campaigns. As previous literature has yet to consider three of our variables, our model

TABLE 4 | Multinomial logit estimations based on the Health Belief Model to get vaccination.

Base outcome assigned to "I am willing to be vaccinated" (yes)	"I refuse to get vaccinated" (no)				"I have not yet decided whether to vaccinate" (hesitant)			
Variable[+]	RRR[++]	SE[+++]	Coef. [++++]	SE[+++]	RRR[++]	SE[+++]	Coef. [++++]	SE[+++]
Susceptibility 1. Family with the possibility of contracting COVID-19	1.1786	0.2395	0.1642	0.2031	1.440**	0.2382	0.3650**	0.1653
Susceptibility 2. A family member has chronic diseases	2.8580**	1.4057	1.050**	0.4918	1.8781	0.7688	0.6302	0.4093
Susceptibility 3. Family or relative with COVID-19	0.1190***	0.0720	−2.129***	0.6053	0.9982	0.3754	−0.0018	0.3761
Susceptibility 4. Chile has one of the highest infection rates per 1,000 inhabitants	0.5942	0.2764	−0.5206	0.4652	0.4616**	0.1763	−0.7731**	0.3820
Severity 1. I consider the severity of complications from contracting COVID-19	0.6627**	0.1327	−0.4115**	0.2002	0.6873	0.1219	−0.3750**	0.1774
Severity 2. I think the vaccine will be ineffective	1.5400**	0.3085	0.4318**	0.2003	1.2255	0.2144	0.2034	0.1749
Severity 3. I have concerns regarding the side effects	2.3327***	0.5046	0.8470***	0.2162	1.6922***	0.3110	0.5261***	0.1838
Benefit 1. I would protect myself and my family	0.4846**	0.1531	−0.7243**	0.3158	0.8767	0.2649	−0.1316	0.3021
Benefit 2. The vaccine will reduce my fear of contagion	0.4993**	0.0952	−0.6945***	0.1961	0.5724***	0.1051	−0.5579***	0.1835
Benefit 3. The available vaccine is effective	0.4256*	0.1967	−0.8540*	0.4620	0.1801***	0.0760	−1.714***	0.4222
Benefit 4. The available vaccine is safe	2.1697*	0.9392	0.7745*	0.4328	2.253**	0.8936	0.8121**	0.3967
Barrier 1. Social networks indicate that vaccinating is inconvenient	0.8670	0.1833	−0.1428	0.2115	0.6030***	0.1143	−0.5059***	0.1896
Barrier 2. I think the vaccine will be very risky	1.5877**	0.3045	0.4623**	0.1917	1.5999***	0.2563	0.4699***	0.1602
Cue_to_action 1. I will wait for others to be vaccinated	1.1646	0.1996	0.1524	0.1713	1.5520***	0.2440	0.4389***	0.1573
Cue_to_action 2. A lack of vaccine knowledge	1.0858	0.1698	0.0823	0.1563	1.6910***	0.2393	0.5253***	0.1415
Cue_to_action 3. The government's communication in response	1.1573	0.3177	0.1461	0.2745	1.8963***	0.4710	0.6399***	0.2484
Cue_to_action 4. Family's response to the pandemic	0.6305**	0.1215	−0.4613**	0.1926	1.1651	0.1801	0.1528	0.1546
Cue_to_action 5. The Medical College of Chile recommended the vaccine	0.8019	0.1945	−0.2208	0.2424	1.2431	0.2716	0.2176	0.2185
Cue_to_action 6. My doctor recommended the vaccine	0.8007	0.1986	−0.2223	0.2479	1.2884	0.2816	0.2534	0.2186
Motivation 1. Religious reasons	0.4449**	0.1340	−0.8000**	0.3011	0.9382	0.2280	−0.0637	0.2430
Motivation 2. The disease was invented by politicians and the pharmaceutical industry	0.7539	0.1770	−0.2825	0.2347	1.1403	0.2437	0.1314	0.2137
Gender	0.4586**	0.1815	−0.7795**	0.3956	0.7495	0.2447	−0.2883	0.3265
Level of Income	1.4423**	0.2098	0.3662**	0.1454	1.2850**	0.1536	0.2508**	0.1195
Relative_work_health_sys	2.5477**	1.0298	0.9352**	0.4041	0.7383	0.2557	−0.3034	0.3464
Work_health_sys	1.150558	0.6585	0.1403	0.5723	0.2611**	0.1777	−1.342**	0.6806
Constant	70.68541	184.18	4.258	2.606	0.0044	0.0112	−5.421	2.536
Number of observations	370							
LR chi[2](50)	284.8							
Prob > chi[2]	0.0000							
Log likelihood	242,888							
Pseudo R[2]	36.96							

COVID-19, coronavirus disease 2019.

*p < 0.10; **p < 0.05; ***p < 0.01.

[+]*Variables are as defined in **Table 2**.*

[++]*RRR, relative risk rate.*

[+++]*SE, standard error.*

[++++]*Coef., Coefficient.*

reduces potential biases due to omitted relevant variables by considering Mokhtarian's (23) work.

The literature on the HBM and vaccines does not address elements associated with altruism as a motivating or benefit variable. However, we included it in the model (benefit 1), and we found that this was a relevant aspect, given the statistically significant finding (**Table 4**). Thus, the probability of rejection of the vaccine was reduced by the variable that measured altruistic motivation. Thus, people would be vaccinated to protect not only themselves but also their loved ones; in other words, there could be less rejection of the vaccine if individuals believe that it helps reduce the transmission of COVID-19. This is consistent with the experiment conducted by Rieger (31), who found that both selfish and altruistic motivations were effective in convincing people to get vaccinated. In addition, Rieger proposed that social preferences affect health behaviors that impact others (32). Thus, this potential benefit of vaccination (protecting others) can be used as a promotional element for the vaccination campaign. According to Farboodi et al. (33), knowing the social impact of individual behavior can be a tool for the formulation of public health policies.

We found that a lower probability of refusal and being undecided manifested in individuals with relatives who contracted COVID-19 and the growth rate of infection per 1,000 in Chile. Therefore, susceptibility does affect individual preferences for the vaccine, which is consistent with Costa's (19) results. Additionally, young people had greater rates of rejection and hesitancy regarding vaccination. Consequently, communication strategies could be implemented to promote vaccination among young people as the main target group, as well as people who already had COVID-19 or with family members who had it, considering that the possibility of reinfection exists according to Centers for Disease Control and Prevention (34).

The identification of variables is key in formulating public health policies, as the HBM indicates that changes in an individual's behavior could be generated through the orientation or direction of barriers, benefits, severity, and susceptibility, among other factors (6). Furthermore, these changes could guide people toward objective behaviors that guarantee that a larger proportion of the population is vaccinated as a preventive measure. In other words, the variables that we discovered are those that should have the greatest influence through communication campaigns that promote the COVID-19 vaccination.

As indicated by results from the H1N1 vaccination campaign in Indiana as examined by Jones et al. (6), an inadequate communication approach was used because the campaign focused on only two elements: severity and susceptibility. In contrast, Fournet et al. (35) found that concern about side effects was a relevant aspect to explain anti-vaccine movements in Europe. Therefore, the design of health campaigns for the COVID-19 vaccine must consider all aspects and not focus only on one. The aspects to be considered are related to the beliefs of individuals that would have the effect of reducing the probability of rejection or hesitancy. Our results demonstrate that there are many variables associated with vaccine-related actions or cue to action, severity (side effects and effectiveness),

benefits, barriers, and motivations that are relevant to individuals' decision making.

Social networks' influence was statistically significant as an explanation for the probability of indecision. Specifically, this result indicates the risk of vaccination strategies as generated by online communities, which can encourage the dissemination of false, biased, or inaccurate information. According to Arfini et al. (36) and Roozenbeek et al. (37), social media are diffusers of ignorance and are exploited by anti-vaccine movements; however, this misinformation is based on health risks as well as conspiracy theories. Consequently, the variable regarding the potential belief that "the COVID-19 disease is a political or pharmaceutical invention" was not statistically significant in our model.

We also found that the government's communication response would affect the probability of vaccination, consistent with an Australian case of non-compliance with COVID-19 measures associated with government confidence (38). Ward et al. (9, 39) indicate that trust in the authorities contributed to the adoption of the vaccine. However, the findings differ slightly from Clark et al. (40), who showed that trust in the government had a low influence on individual decisions to take other preventive measures against COVID-19 (including mask wearing, social distancing, handwashing, and staying at home). This could be due to the fact that preventive measures are valued differently by people, such as, valuing the vaccine more than the use of a mask, which could be explored in future research.

Considering the importance of social media and trust in the government, communication from the government is considered key to promote vaccination as a measure to prevent contagion. Further, it highlights the need for health authorities to use scientific data to counteract the erroneous information disseminated on social media and adequately inform citizens of the COVID-19 vaccine's benefits and risks. There are studies that indicate the need to incorporate the relationship between the information transmitted by governments and the role of social networks in the design of vaccination campaigns against COVID-19 (11, 41). Thus, people's trust can be fostered through clear, transparent, and timely information based on scientific knowledge. According to Bles et al. (42), such information would be perceived as more open and transparent and therefore result in a greater willingness of people to get vaccinated (37), which may be achieved by following the recommendations of Mheidly and Fares (43). Similarly, our statistically significant variables mentioned in the *Results* section can help authorities to design communication strategies focused on anti-vaccine movements, as such variables that can help them understand the beliefs of those who reject vaccines. In this regard, we observe that religious beliefs statistically explained the probability of vaccine rejection, which is typically one variable that influences anti-vaccine decisions (44).

Strengths and Limitations

There are several strengths and limitations of our study that deserve mentioning. Among the strengths are identification of the variables that affect both the probability of refusal and hesitancy of being vaccinated for COVID-19 in the context of

the HBM. Among these variables, the role of social networks, altruism, the perception of severity of the disease, fear of side effects, and susceptibility to contagion are prominent. These can guide the design of vaccination campaigns targeting messages to undecided or anti-vaccine groups, such as young people. Another notable strength is the use of three possible scenarios to be able to determine the intention to get vaccinated, showing that individuals prefer having fewer side effects more than the effectiveness of the vaccine itself. Furthermore, the scenario with the least hesitation was one in which the vaccines were approved in both the United States and Europe.

With regard to limitations, our sample includes a high proportion of people with relatively high education levels, and a convenience sampling and snowball recruitment method was used. This limits the generalizability of the results. Another limitation is that the results of probability of acceptance, refusal, and hesitancy are marked by the temporal context of the pandemic; therefore, they could change over time.

CONCLUSIONS

The analysis of preferences for different hypothetical vaccines indicates that people value a vaccine's minor side effects more than its effectiveness. This provides evidence regarding the importance of rigorous human testing for any vaccine, and the significance of communication with society regarding its side effects. Collectively, these will directly affect individuals' vaccination preferences and decisions.

We also revealed the key health beliefs that positively or negatively affect the refusal and hesitancy of a hypothetical COVID-19 vaccine. These should be used in formulating public health policies, and specifically in designing promotional strategies for the vaccine. Furthermore, specific promotional campaigns can be aimed toward different anti-vaccine and undecided groups, such as, younger people, influencing beliefs, cue to action, perception of severity (side effects and effectiveness), benefits, barriers, and motivations.

On the one hand, the variables that explain rejection could be used to counter anti-vaccine movements through public health communication strategies. These strategies should effectively address citizens' concerns with side effects and potential health risks by disseminating information through not only associations with doctors and health personnel but also social networks. On the other hand, the promotional strategy to mitigate hesitation could focus more on the government's communication response and increasing the population's knowledge of the vaccine, in addition to its risk factors, effectiveness, and side effects. However, even hesitant groups could be protected through herd immunity given sufficiently high vaccination rates in the general population. This could boost the vaccination rate as a result, which is key to controlling COVID-19 outbreaks and recurring infections.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

The authors contributed equally to the writing of this manuscript.

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COVID-19 and Vaccination Campaigns as "Western Plots" in Pakistan: Government Policies, (Geo-)politics, Local Perceptions, and Beliefs

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Vaccination encounters multiple context-specific challenges—socio-cultural, economic, and political—that substantially affect its uptake. Likewise, natural disasters and health emergencies considerably impact immunization endeavors, such as the coronaviurs 2019 (COVID-19) pandemic that has overwhelmed the entire world. It was already anticipated that the pandemic would severely affect Pakistan's vaccination programs due to interruptions in routine vaccination and the overstretching of healthcare systems. Consequently, there are anticipations of outbreaks of other vaccine-preventable diseases (VPDs). Yet empirical evidence is missing. Drawing on qualitative research, this article focuses on the impact of COVID-19 on routine vaccination programs in Pakistan. Our data come from a small village located in Pakistan's Sindh province where local people refused the routine polio vaccine that was stopped for a while, then resumed in July 2020. They suspected both the vaccine and COVID-19 to be a "Western plot." We argue that these perceptions and practices can be seen against the backdrop of economic, socio-cultural, and (geo)political forces, which are encoded in "societal memory." Not only is there a need to reverse the significant impacts of COVID-19 on routine vaccination by arranging supplementary immunization activities (SIAs), but also the government must deal with other pressing issues that affect the vaccination programs in the country.

Keywords: COVID-19, polio, vaccination, local perceptions, (geo-)politics, rumors, (mis-)trust, mistrust vaccine preventable diseases VPDs

INTRODUCTION

Vaccination faces several challenges across the world that are context-specific (Nichter, 1995; Feldman-Savelsberg et al., 2000; Ali, 2020a,c). Among socio-cultural, economic, and political factors, natural disasters and health emergencies such as the coronavirus (COVID-19) pandemic considerably affect immunization endeavors (Ali, 2020c; World Health Organization, 2020). This pandemic has posed serious challenges to and interruptions in

routine immunization activities around the globe, such as the need for physical distancing and the fact that COVID-19 has overwhelmed healthcare systems in many countries to the point where many vaccination programs have been temporarily halted (Ali, 2020d).

There is evidence that when vaccination is halted as resources are shifted elsewhere, vaccine-preventable diseases (VPDs) cause severe outbreaks, as was observed during the Ebola outbreak in West Africa (Masresha et al., 2020). Drawing on their risk-benefit analysis of routine childhood immunization in 54 African countries, Abbas et al. (2020) argue that the benefits to continuing routine childhood immunization programs outweigh the risk of COVID-19 contagion related to vaccination clinic visits. To continue vaccination, they suggest the use of necessary protective measures—physical distancing, personal protective equipment (PPE), and effective hygiene practices—to prevent COVID-19 transmission during vaccination administration encounters.

In this article, we argue that, both during the pandemic and in normal times, vaccination campaigns in low-resource settings face multiple challenges, especially when factors like (geo)politics are in play. For example, in Pakistan, socio-cultural, economic, and (geo)political factors significantly shape local perceptions and practices around both COVID-19 and vaccine administration (Abimbola et al., 2013; Ali, 2020b). Rumors and conspiracy theories have long been affecting vaccination programs in Pakistan (Abimbola et al., 2013; Khan and Chiau, 2015; Ali, 2020a,b).

During the pandemic's early days, it was rightly anticipated that COVID-19 containment measures would substantially affect routine vaccination programs. There were no empirical evidence for this, simply plausible assumptions. Yet by now, these assumptions have been verified (Ali, 2020b). It was also predicted that due to distinct socio-cultural, economic, and political factors, the impact of the pandemic on vaccination programs would be distinct in low-income countries like Pakistan (Ali, 2020b). There is also convincing evidence that one out of every two children has missed their routine vaccinations in Pakistan's Sindh province during COVID-19 (Chandir et al., 2020).

Chandir et al. (2020) have explored a 51% decline in overall immunization visits in the province that they claim are due to a reduction in the provision of immunization services, due to strict restrictions on the movements of vaccinators to do outreach, and to stock-outs resulting from disruptions in global manufacturing and supply chains, border closures, and general restrictions on local mobility (ibid.). On the demand side are the fear and hesitancy of parents to get their children vaccinated due to possible infection exposure, and to "myths" and misinformation about vaccination and rumors surrounding COVID-19, lockdown restrictions, unavailability of public transportation, and an increase in commuting costs (ibid.). In Pakistan, immunization activities have been significantly more affected in rural areas than in the Sindh province's urban areas (ibid.), where we conducted our research. In this article, we focus on government responses to COVID-19 and their effects on vaccination programs, and on myths and rumors that underlie local people's resistance to vaccination, and to government measures to control viral spread.

From the firsthand data we have obtained from a small village situated in rural Sindh, we learned that local people sent the "polio" vaccination teams back because they believed that both vaccines and the coronavirus are "Western plots." What they refused were actually routine vaccinations for measles and Bacillus Calmette–Guérin (BCG), thinking that the vaccines offered were for polio. With the help of our past ethnographic data on vaccination (mainly collected in 2014) and our current research on COVID-19 in Pakistan, we present what factors affect people's choices to refuse and show resentment against vaccination and shape their anti-vaccination sentiments and explain why they consider these to be "Western plots."

MATERIALS AND METHODS

This qualitative study obtained rapid information on the impact of COVID-19 on vaccination during August–September 2020. We divide this section into two parts for clarity: data collection (methodology) and the locale.

Data Collection: Methodology

Since this is a rapid response study, Shahbaz Ali conducted 2 weeks of fieldwork during August–September 2020 in the locale where he had previously conducted his M.Phil. research on asthma. Due to this previous research in the same area and being part of Sindh province, he neither needed to take time to build the required rapport nor to learn the language, as Sindhi is his mother tongue.

Building on these advantages, Shahbaz conducted several group discussions using a method that lead author Inayat Ali has called *Kachahārī* (Ali, 2020a). This method begs a brief explication. *Kachahārī* is a local word that means discussions; ethnographically the *Kachahārī* method as Ali has developed it is an adaptation of the "focus group" discussion, with the difference that the discussion is driven not by a researcher but by participants; it builds on an existing culturally recognized local social process for discussing and solving a particular problem.

Using purposive or convenience sampling and an interview guide, Shahbaz organized 10 *Kachahārīon* discussions of 2–3 h each with almost 50 adult males at their *Otāq* (guest house for male members). The interview guide had four main areas: (1) local perceptions and practices around COVID-19; (2) local perceptions of vaccination; and (3) the underlying reasons for vaccine refusal.

The data gathered during this fieldwork included no personal health information but did include an overall description of experiences and perceptions of COVID-19, in which we found that these people refused routine vaccines such as BCG, thinking that, as previously noted, this was only the polio vaccine, and relating both COVID-19 and vaccination to the "Western" world. Thereafter, our focus was given to both phenomena—perceptions, and refusals. The *Kachahārī* discussions took place in the Sindhi language. Although these village inhabitants speak Balochi as their mother tongue, they are also proficient in Sindhi, which is the lingua franca of Sindh province.

With the permission of interlocutors, some discussions were audio-recorded. After transcribing the data into English and

examining them using thematic analysis, we analyzed this data by reading the entire dataset several times to identify relevant themes, followed by listing, summarizing, reviewing, and refining these various themes. Our analysis addressed the following questions: (1) How do local people perceive COVID-19, and what practices do they perform to deal with it? (2) What are local perceptions of vaccination and why do people refuse it? (3) Why do people see COVID-19 and vaccination as "Western plots?"

Shahbaz Ali wore a mask during the *Kahchāri* sessions, whereas the village participants did not wear masks though they did maintain physical distance. To obtain the interlocutors' consent, Shahbaz informed them about the aims of the study.

The Locale

The setting of this study is thoroughly described by second author Shahbaz Ali in his previous research (Ali, 2018). Briefly, the village is located in a desert area of Sindh province. With a population total of 150 households, it lies at a distance of around 70 km from the third-largest city of the province, called *Sakhar*. Most of the inhabitants are engaged in animal husbandry, agriculture, and daily wage labor. Some are government employees, such as primary school teachers. Most people are not formally educated, and the highest formal education degree is "master" (16 years of education). The education rate differs significantly gender-wise, as more men have formal education than women.

Many inhabitants do have religious education, as they can read the Holy Quran and perform *Namaz* (prayers). The village has neither health facility nor proper sanitation. Almost every inhabitant of this village perceives health and illness as predetermined and an act of God or of fate (*Qismat*). They practice medical pluralism: (a) home remedies that have roots in Unani medicine and Ayurveda; (b) verbal healing that includes prayers, offerings, and chants of specific verses of the Holy Quran; (c) visiting sacred places such as shrines of saints; (d) consulting a *Hakeem* (an herbalist who practices Unani or Ayurveda systems); (e) visiting a biomedical facility. This health-seeking behavior further differs in terms of the disease's etiology, a person's gender, and the family's economic situation, and access to healthcare facilities all of which affect people's choice to ignore a disease or to utilize a specific healthcare system. In the following sections, we present overviews of COVID-19 and vaccination programs in Pakistan as background and context for our study results.

COVID-19 IN PAKISTAN: AN OVERVIEW

Pakistan reported the first infection of COVID-19 in two men who returned from Iran on February 26. Over time, infections increased; at the end of March 2020, the country reported around 1,400 people infected by the virus and 11 deaths. By 11 June 2020, the virus had infected around 120,000 people and caused over 2,000 deaths. By 10 December 2020, the virus had infected approximately 430,000 people, out of which over 8,600 have "officially" died (Johns Hopkins University, 2020). This may seem like a very small number of deaths out of so many cases; in other work, first author Inayat Ali (in press) has shown how the Pakistani government may be fabricating these numbers in order

to make it appear that they are doing an excellent job of coping with COVID-19.

To contain the virus, "flatten the curve," and safeguard public health, the Pakistani government has implemented several measures. At the beginning of the pandemic, flights to and from China, then Iran, Qatar, and Italy were suspended (Ali et al., 2020). Due to the unavailability of test kits in the country, the country sent specimens to China and the USA, and later on, imported 1,000 kits from China (Ali et al., 2020). On 13 March, when only around 30 people were infected, the government closed educational institutions and the border with Afghanistan and Iran and opened a quarantine camp for COVID-infected people at the Pak-Iran border (Khan, 2020). Afterward, the country banned congregations, including conferences and gatherings. On 17 March, the country's Prime Minister ruled out the option of lockdown while considering that 97% of patients recover (Ali et al., 2020), but the government of Sindh province implemented a lockdown anyway. Later on, the federal government announced a countrywide lockdown; deployed security forces to enforce COVID-19-infected people's entry into quarantine centers, of which more had been established; invoked Section 188 of the Pakistan Penal Code for violations; shut the markets; monitored inter-provincial borders; created a Corona Relief Tiger Force to educate people about the critical consequences; distributed food items among daily wage laborers, and approved a PKR1.2 trillion economic relief package (Ali and Ali, 2020; Ali et al., 2020). On the 9th of May 2020, the government lifted the countrywide lockdown, despite the fact that the wealthy, "elite" population wanted to extend it; and introduced and implemented a "smart" lockdown to place only virus hotspots under lockdown (Ali and Ali, 2020; Ali et al., 2020). Under this smart lockdown, educational and training institutions, restaurants (except for take-away), marriage halls, cinemas, business centers would remain shut. Sporting, social, and religious events were also banned.

Currently (as of December 16, 2020), "smart" lockdown is still under operation, yet many people are organizing marriage ceremonies. Moreover, there are specific socio-cultural, economic, and political factors that create a conducive environment for the virus to exert severe consequences in the country (Ali and Ali, 2020); we detail some of these below.

VACCINATION IN PAKISTAN: BACKDROP

Vaccination began in Pakistan in the 1970s, after the country signed the Charter with the United Nations (UN) to contain and eliminate various communicable diseases. Commencing the Expanded Program on Immunization (EPI) in 1976 on a pilot scale, it was extended across the country in 1978 (Ali, 2020a). Although the EPI in the beginning intended to protect children aged 0–11 months against six contagious diseases—childhood poliomyelitis, tuberculosis, diphtheria, tetanus, pertussis, and measles—to reduce child mortality and morbidity, over time, new vaccines were introduced, such as hepatitis B in 2002, Hemophilus influenza type b (Hib) in 2009, pneumococcal vaccine (PCV10) in 2012, and inactivated polio vaccine in

2015 (Ali, 2020a). Moreover, vaccinations are also given to pregnant women.

The EPI follows a top-down approach: federal, provincial, district, sub-district, and Basic Health Unit (BHU) levels. There are facilities for maintaining the cold chain at all these levels. The Executive District Officer (EDO) works as the district head and is responsible for receiving the vaccines. Also, there is an EPI focal person who is responsible for all duties, from storage to distribution. To ensure the vaccinations, the monitoring teams visit the field and interview the target group—parents. The frequent questions include: (a) Does a vaccinator visit your village to vaccinate your children? (b) Could you please show us the vaccination card, if your child is immunized? Moreover, the card shows, the vaccination status of that child in the absence of the card, the BCG scar is checked and considered as proof the child was vaccinated.

Each union council (UC) contains a BHU functioning under a medical officer (MO). Moreover, as a month starts, vaccinators of every BHU visit the district level office to receive vaccines according to the target population. A vaccinator maintains a stock register, which encompasses all daily records of a vaccine— the amounts received, used, and remaining. The MO supervises the entire process. At a UC level, the vaccine is stored in the respective BHU at a controlled temperature and then distributed among vaccinators according to the due and defaulter list for the vaccination.

Introducing "E-Vaccs"

For making the vaccination program more "efficient" and "effective," primarily through overcoming the problems related to inadequate geographical coverage and insufficient performance of field vaccinators, the EPI of *Punjāb* has revisited its strategies via adding smartphone technology: a digital system called "E-Vaccs" (electronic-vaccination) for ensuring the vaccinators' attendance in the field (Ali, 2020a). Following the same methods of e-health for using information and communication technologies (ICT) via the internet, the system comprises a smartphone application to record real-time immunization coverage in a centralized database. The application was introduced in June 2014 in Punjab's four districts as a pilot project and was implemented across the Punjab's districts by October 2015. The introduction of smartphones with GPS trackers is an innovative idea purposing the improvement of vaccinators' attendance in the field for ensuring vaccination to every child.

After introducing the E-Vaccs, the vaccinators' attendance dropped significantly, from 97 to 54%, which appeared a critical development due to a few probable reasons. First, the technology was new and perhaps too advanced for many vaccinators, who were unable to understand and use it efficiently. Second, vaccinators considered that nothing significant would happen if they did not mark their attendance on it, as it has been in the past. Third, they showed resistance to this application because it would increase their accountability at the district level. They would no longer be able to mark themselves present by proxy; therefore, they wanted to make this move fail. Forth, some of them "lost" their smartphones and were using that as an excuse.

However, effective use of this app increased to 94% after fixing the problems cited above, because the vaccinators received training at the district level to impart the skills and knowledge to operate the phones appropriately; regular monitoring commenced; and the absentees received show-cause notices. Except Sindh province, this smartphone technology was launched in the Khyber Pakhtunkhwa (KPK) and *Baluchistān* provinces in 2016.

Moreover, another pilot program—*Har Zindagi*—was operational in the *Punjāb* province's two districts, *Sāhiwal* and *Sheikhupurā*, and will be implemented in the whole province and the country once it is shown to be successful (Sarwar, 2017). Working as a tool for maintaining the vaccination record at the household level by the parents, this new immunization card has the color and design akin to the country's passport (green) with the purpose of parents' intentional respect and vigilance. It has a Near-Field Communication tag inside, which enables real-time data sharing between the E-Vaccs application of the vaccinator and the card in the smartphone once both are tapped together. This application will work as an alarm through Robo-calling and a short message service (SMS) for vaccination dates for the parents.

One genuine criticism of this technology-driven initiative could be that it implies that everyone in Pakistan has a smartphone, but most of the villagers do not have one. Yet there can be multiple reasons behind difficulty of use, such as economic affordability, low or no electricity to charge phones, and low internet bandwidth speed. Thus, it is essential to ask, what provisions are made for those who do not have and cannot afford a smartphone nor a means to charge one? So far, there are no visible efforts of the government to address these issues.

Failing to Meet Vaccination Benchmarks

Pakistan still needs to achieve the expected benchmarks. The World Health Organization (WHO) accepts that despite the government's efforts and the WHO's noteworthy partners, the country has yet to meet the immunization indicators (World Health Organization, 2019; Ali, 2020a). The primary goals of eradicating polio, measles, and neonatal tetanus remain unachieved thus far. We note that although polio has been eradicated in most of the world, there are still recurrent polio outbreaks in Pakistan due to lack of full vaccination coverage. Numerous outbreaks of measles, pertussis, and diphtheria in several parts of the country are further evidence of poor routine coverage.

Moreover, there are substantial issues in cold chain maintenance, lack of skilled vaccinators, and weaknesses in the catchment areas in terms of distance and geographical location (Khan and Chiau, 2015). These factors, which include people's perceptions as described below, significantly affect vaccine uptake. For instance, in September 2015, the *Dawn* newspaper published a report: "Over 75,000 children in Sindh never received polio vaccine" (Mansoor, 2015). According to this report, around 440,000 of the country's children never received the polio vaccine, and out of them, 56% are in Baluchistān, 17% in Sindh, 14% in the Federally Administered Tribal Areas (FATA), and 12% in KPK. These numbers accurately

demonstrate the state of vaccination in the country, though the figures are about polio vaccination. If polio vaccination is in such a critical state despite securing enormous attention from the governmental and global stakeholders, then one can predict that there is something critically wrong with the country's entire immunization program.

According to Mushtaq and colleagues, from 2003 to 2006, polio was transmitted to approximately 24 otherwise polio-free countries, causing around 1,400 cases, most of which had originated in Pakistan (Mushtaq et al., 2015). In 2007, Australia reported a poliovirus infection in a man who had traveled there from Pakistan (Stewardson et al., 2009). Likewise, the strains of the poliovirus in cases identified in China, Egypt, and Palestine during January 2012, December 2012 and March 2013, respectively, were also traced back to Pakistan (Luo et al., 2013). This led, the Saudi government to make polio vaccination mandatory for Pakistani travelers to Saudi, especially for the Hajj and Umrah[1]. In 2011 and 2020, the WHO also made it compulsory for Pakistanis who would like to travel abroad to show a vaccine card at airports (Ali, 2020a; Chaudhry, 2020).

Pakistan is one of the two polio-endemic countries; the other is its neighboring Afghanistan. Both have collectively contributed 85% of recent polio cases globally (Ali and Ali, 2020). As noted above, in 2019 the country reported around 150 people infected with poliovirus, and by April 2020, there were around 30 newly infected people (Global Polio Eradication Initiative (GPEI)., 2020). The wild poliovirus is still prevalent in Pakistan and Afghanistan. The country also has been reporting new measles outbreaks (Ali, 2020a,b). Maternal and neonatal tetanus also prevails in the country (Iqbal et al., 2020).

All these VPDs reveal substantial issues in the Expanded Program of Immunization (EPI). As described above, low vaccination uptake results from the problems related to administering vaccines, and from people's distrust of vaccines, of the government, and of the global stakeholders. The phenomenon of vaccine refusals is complex and related to "the histories, politics, and social structures" (Closser et al., 2016). Also refusals are associated with the government's failure not to meet other responsibilities toward people (Closser et al., 2015). Parents' refusals and resentment chose not to vaccinate children are strong in those areas where the Pakhtun population lives due to a dearth of requiring knowledge about vaccination, low income, and formal education levels, as well as the number of children per household (Shah et al., 2019).

Consequently, a growing number of children remain unvaccinated. The recent *Pakistan Health and Demographic Survey* revealed that only 51% of children in Pakistan had all age-appropriate vaccinations (National Institute of Population Studies (NIPS) [Pakistan] ICF, 2019). That means almost half of the children receive no vaccine according to their age.

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[1]Hajj and Umrah are holy pilgrimages for Muslims, during which they travel to Makkah and Medina cities of Saudi Arabia to visit the holy *Qabā* and the shrine of the Prophet Muhammad.

Vaccination During COVID-19: Global Worries About Vaccination Programs

COVID-19 is an emergent and continually evolving phenomena. As its prevalence escalates in "developing countries," it will significantly affect the weak healthcare systems of low-income settings. Various health initiatives, including ongoing vaccination programs, have been affected due to several interruptions in them resulting from the overstretching of healthcare systems (Ali, 2020b). The United Nations has expressed concerns about the millions of children who will not receive vaccinations against measles, diphtheria, and polio, and who will then be at critical risk of infection (United Nations News, 2020). During March 2020, the WHO's Strategic Advisory Group of Experts on Immunization (SAGE) recommended to all countries to suspend mass vaccination drives against all VPDs (Roberts, 2020). This suspension of vaccination will result in 78 million unvaccinated children for measles alone (ibid.). This aggregate would significantly increase if the remaining countries are counted or other VPDs are considered.

Besides measles, COVID-19 may substantially affect the longstanding Global Polio Eradication Initiative (GPEI). The GPEI had already directed countries to postpone their mass vaccination programs until the second half of 2020: these campaigns reach around 400–450 million annually (Roberts, 2020). WHO's Michel Zaffran—the head of GPEI—fears that the poliovirus will likely spread further to polio-free countries (Roberts, 2020).

STUDY RESULTS

In this section, we divide our results into two subsections: the local perceptions of COVID-19 and the local perceptions of routine vaccination.

Local Perceptions of COVID-19

Local perceptions and practices play a pivotal role in whether or not the government measures can be effective. Here we describe these village people's knowledge, attitudes, and practices during the extraordinary event of COVID-19. Around the country, various, and distinct rumors have circulated regarding the existence of COVID-19 and its potential treatment, such as drinking green tea, shaving one's head, or performing certain rituals and prayers (Ali, 2020c). Based on their perceptions and practices, people in Pakistan can be divided into two groups: those who have ignored COVID-19 and those who become fearful and panicky after taking the virus seriously.

Similarly, conspiracy theories have revolved around the pandemic, considering it a "Western," an "American," or "Jews" pot (Ali, 2020c; Ali et al., 2020; Salma et al., under review)—a conspiracy of the Western world against the rest. For example, one interlocutor argued, "The West has created this virus as a conspiracy to affect us. The media also tell about it. Because of this creation, the entire world has been affected now." These people think that the purpose of this "plot" is to sterilize Muslim women to control the population, as they believe that the "West" fears an increasing Muslim population (Ali, 2020a,b). They are

not wrong in making that assumption—as evidenced by the protests in Europe against Brown and Muslim immigration, the tendency of white Americans to suspect that all Muslims may be "terrorists," and of white people in general to consider themselves "superior" to all *Others* (Kaunert et al., 2015). This "superiority complex," rooted in colonization and imperialism, both invokes white dominance and makes the "Others" to feel inferior and degraded, provoking (often invisible) resistance. Anthropology has long critically examined this *us* vs. *them* mentality as revealed in projects of "development," "progress," racism, colonization, and imperialism (Asad, 1973; Escobar, 1995; Acosta et al., 2020; Terror, 2020). The roots of this local resistance toward vaccination must be understood within this overall geopolitical context. From this perspective, we can understand how vaccination may be perceived at the local level not as a life-saving endeavor but as a "political project" (Ali, under review). In fact, in Pakistan the seeds of resistance against vaccination germinated as long ago as 1953, when many Pakistanis refused the government-initiated Family Planning Program, which they viewed within this context as "Western" effort to limit their reproduction. Thus, when the EPI was started across the country in 1978 after a pilot project in 1976, people suspected that the program was a tactic of the government and the Western world designed to ensure that fewer Muslims would be born (Ali, 2020a).

Returning to the village under study, we note that within this village, people have not followed the prescribed preventive measures, such as physical distancing and wearing masks. Yet, while going outside the village, especially to a nearby small town to buy common daily goods, they have been compelled to take these measures due to fear of the police. The following words of an interlocutor in his 50s describe this situation:

> At our village, primarily at home, we have not followed measures, such as maintaining physical distancing and wearing masks strictly. However, when we went outside the village to buy food or other daily use items, we had no mask because it is expensive for us; we covered our nose and mouth with a handkerchief. This was especially due to a fear of police who were doing surveillance and putting a fine on the one without a mask. They were beating [people] as well as receiving money.

This man's words index the corruption that is syndemic in both the police and the Pakistani government. In its Corruption Perception Index for 2019, Transparency International reported that Pakistan stands at 120th out of 180 countries in terms of reducing corruption, revealing an increase in corruption compared with 2018 (Ali and Ali, 2020). This constant practice of corruption is one among the leading factors that inhibit the country's economic growth, making it vulnerable to foreign aid "dependency syndrome" (ibid.).

On the one hand, these local people considered the virus to be a "Western plot," and on the other hand, as challenging and threatening. They were fearful of contracting it. During one group discussion, the participants unanimously opined:

> We have been extremely anxious that the virus may affect us. Whoever coughed or sneezed in our village, we thought that the coronavirus had infected him/her. Thereafter, we tried to avoid

that person. We have become suspicious. One person from our village started coughing and sneezing and asked us if this virus has infected him. At first, we ignored what he was saying, considering it as a joke. However, his cough and flu continued for a few days and then fever also occurred to him. After that, we become serious about him, since he was also asking us to bring him to a hospital. He was saying to us, "I am telling you that this virus has infected me. Please bring me to a hospital; otherwise, I may die." His situation and his constant pleadings compelled us to make a distance from him as well as bring him to a doctor. After a few days of that severe onset, his family brought him to a doctor, who was also suspicious but gave him some medication. This person was not hospitalized because he had no severe issue with breathing. The doctor recommended him to maintain physical distancing and perform self-quarantine. Thus, when he returned to the village, this person was himself avoiding us to meet or talk while repetitively uttering to make us cautious, "Please go away from me, because I have coronavirus."

Local Perceptions of Routine Vaccination

In this section, we focus on how local people perceive routine vaccination during the ongoing pandemic and why they refused the polio vaccine and sent the mobile vaccination teams away (In Pakistan, there are two types of vaccination teams: mobile/outreach teams who visit each house to give the routine vaccines, and the fixed teams who sit at specific places to vaccinate children).

During COVID-19, on July 20, 2020, Pakistan resumed its vaccination campaign, which had been halted in March due to the pandemic, to reach around 800,000 children. With masks and gloves, vaccinators restarted vaccinating children (Reuters, 2020). Yet given the rumors and conspiracy theories revolving around COVID-19 in Pakistan (Ali, 2020c), inhabitants of this village also suspected this newly renewed routine vaccination program (Reuters, 2020). Their concerns are rooted in past vaccination drives as well as in the current rise of COVID-19.

First, these people refused the polio vaccine because they did not believe it would do their children any good. As one interlocutor stated, "As soon as the vaccination team arrived here, we promptly asked them not to vaccinate our children and return because they have been vaccinating our children for a long time. Yet, the health of our children does not improve. Many of them remain sick. Given that, what is the purpose of having our children vaccinated?"

Secondly, the local people linked the current vaccine drive to the ongoing pandemic. Their previously noted suspicions around COVID-19 also spilled over to vaccination. Considering the coronavirus's spread to be a "Western production," they think that the vaccine is a product of the *Angraiz* (British)[2]. For example, one interlocutor stated, "It seems this virus is a product of the Angraiz. And if this assumption is true, then all medicines, including vaccines, are their production. Who knows what type are these vaccines, and what if we allow vaccinators to vaccinate our children and then our children die?"

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[2]Due to its long tenure as a British colony, many people in Pakistan use the generic word *Angraiz* for every person with white skin from the West. For instance, in common discourse, they rarely distinguish between a person from Austria and one from the United Kingdom.

Some interlocutors stated that vaccinators should give them a written document to mention that nothing bad will happen to their children after receiving the vaccine. Or, vaccinators should provide their Computerized National Identity Cards (CNICs) for the same purpose.

DISCUSSION: VACCINATION PROGRAMS AND COVID-19

Vaccination in many countries is a complex phenomenon. It has constantly remained under the spotlight due to its success stories as well to its failures (Feldman-Savelsberg et al., 2000; Blume, 2006; Closser, 2010; Fairhead and Leach, 2012; Greenough et al., 2017; Ali, 2020a). On the one hand, its advocates draw on the success story of the smallpox eradication and the prevention of thousands or millions of infections and deaths. This leads to worldwide continuous vaccine drives to vaccinate millions of children. On the other hand, as we have seen, its opponents suspect the ingredients and motives of its administrators. These suspensions and resentments result in a growing number of vaccine refusals and unvaccinated children. Although both perspectives can be found almost in every country, both are extremely prominent in low-income countries due to their lower educational levels and to the prevailing issues of mistrust in their governments and in global stakeholders, as we have described above.

Similarly, rumors and conspiracy theories have surrounded COVID-19 across the world due to uncertainty, anxiety and fear regarding a constantly evolving phenomenon of COVID-19 (Ali, 2020c; Ali et al., 2020; Jolley and Paterson, 2020; Romer and Jamieson, 2020; Uscinski et al., 2020). These narratives should be considered as "social phenomena" revealing interplay between various socio-cultural, economic, and (geo-)political factors (Ali, 2020c). These narratives would affect the upcoming vaccination against COVID-19, thus, it is necessary to understand the underlying factors (Ali, 2020a,b; Jolley and Paterson, 2020; Miller, 2020; Romer and Jamieson, 2020).

Likewise, the narrative of both COVID-19 and vaccination programs as "Western plots" has remained strong across the country, due in large part to the "fake" vaccination drive organized by the US in 2011 to locate Osama-bin-Ladin (Ali, 2020a,b) and to the American drones they see flying around, which they feel are "spying on them." Owing to these various rumors and conspiracy theories linked to different past realities—such as British colonization or an almost decade-old "bogus" vaccination campaign—vaccination uptake in Pakistan has remained under par (Ali, 2020a). These strong perceptions and suspicions have had drastic consequences that include assaulting vaccination teams; over 100 vaccinators have been killed, despite the government provision of police escorts (Closser and Jooma, 2013; Ali, 2020a,b).

People also negotiate vaccines with the government. In return for having their children vaccinated, economically poor and marginalized people want to get something back from the government, especially economic support, which they rarely receive (Ali, 2020a,b). Both their perceptions and practices have their roots in the various socio-economic, economic, and political factors of the country, which play a pivotal role in the shaping of distinct imaginaries and actions (Ali and Ali, 2020). The views of local people of that selected village reflect such deeper and broader contexts: national and global. And their standpoints should be understood as the backdrop of this interplay between national and global contexts. These perceptions and practices of past abuses, injustice, and exploitation are preserved in "societal memory" (Ali, 2020a; Ali and Davis-Floyd, 2020).

The critical view to refuse the vaccine, to consider it dangerous to children's health, and to link it with the "West" also needs to be situated within the various forms of structured inequalities and inequities at play; as Famer argued, these various structures shape people's views and underpin the preparedness programs during any health emergency (Farmer, 1996). In other words, as a result of such disparities, the poor and rural receive less government attention and a lower quality of health care than the wealthy and the urban.

Studies show that people's perceptions of the COVID-19 pandemic as an "American" or "Western" plot impede polio eradication in Pakistan and create fertile ground for measles and other VPDs to flourish (Ali et al., 2020). Moreover, limited outdoor movement and lockdown policies might play pivotal roles in affecting the ongoing routine vaccination programs, as people fear that physical interaction may expose them to COVID-19 infection and so will not visit a healthcare facility to vaccinate their children. Likewise, many vaccinators also fear contagion and may refuse to perform routine vaccination (Ali, 2020b). Consequently, as we have shown, the COVID-19 pandemic is greatly affecting routine immunization coverage in Pakistan and augmenting vaccine hesitancy at local levels.

To control VPDs and to run effective routine vaccination programs thus require significant efforts. They necessitate a political, judicial, and economic infrastructure that provides a base to build a stable, secure, and proper society: a society that can thrive in ordinary times and effectively respond to extraordinary times. Not only vaccination programs, but the entire healthcare system is also intricately linked with corrupt governance, insufficient public works, injustice, ineffective social services, inadequate education, challenging subsistence patterns, and the natural environment. These factors affect the spread of infectious diseases and their courses in those affected (Farmer, 1996; Ali, 2020a; Ali and Ali, 2020). To improve this situation, effective, non-corrupt governance in the stated areas is essential to provide adequate healthcare. Political stability and governmental effectiveness provide immunization to "social and political bodies" (Scheper-Hughes and Lock, 1987) against corruption, social conflict, and instability, just as vaccination immunizes the physical body against numerous microorganisms. As infections weaken the physical body, so there are factors that weaken the entire socio-cultural and politico-economic systems of society, in which healthcare is also embedded.

LIMITATIONS AND STRENGTHS OF THE STUDY

This study holds several limitations. Firstly, it involved only 50 male interlocutors who may not be speaking for the entire village, especially for its women. Secondly, it is a rapid response study based in part on only 2 weeks of fieldwork, though it draws on extensive previous fieldwork. Owing to these limitations, the results cannot be generalized. The great strength of this study is that it is likely the first to collect first-hand data from local people on how the pandemic has affected routine vaccination programs. From this perspective, the study has great scope, as we hope that it will trigger further research on this topic. An additional strength lies in its geographical focus, as vaccination in Pakistan remains under constant negotiation, and viruses such as polio and measles still cause significant outbreaks in that country.

CONCLUSION AND RECOMMENDATIONS

Despite the fact that one of the Sustainable Development Goals 2030 emphasizes the need to develop and distribute vaccines and medical research with easy access to cheap essential medicines and vaccines, especially for developing countries (World Health Organization, 2018), vaccination remains a pressing issue in low-income countries like Pakistan. This life-saving endeavor has become a politicized project, and due to that one of us calls for "an anthropology of vaccination" (Ali, under review). Moreover, because of these multiple factors working against effective routine vaccination programs, we can anticipate ongoing outbreaks of VPDs such as measles and polio, as well as refusals and resistance toward the COVID-19 vaccine in Pakistan and most likely in other countries as well.

Not only is there the need to reverse the significant impacts of COVID-19 on routine vaccination, but also it is crucial for the government to deal with the pressing issues that affect the vaccination program in the country. For this, effective, non-corrupt governance that equally attends to the rural poor's needs is essential to provide adequate healthcare. Again, *governmental stability, honesty, transparency, and effectiveness provide immunization to social and political bodies against corruption, social conflict, and political instability*. Just as infections weaken the physical body, so the infections of corruption and structural disparities weaken the governmental body and impede it from effective governance for all.

Undoubtedly, all efforts should be made to run the routine vaccination drives during these Covidian times to avert further challenges posed by other microorganisms. Yet, we argue that such programs will remain ineffective until the Pakistani people, especially the rural poor, are sufficiently educated in need for, the ingredients in, and the effectiveness of vaccines, as well as in the very real dangers of vaccination refusal. They say that their children get sick despite being vaccinated; they need to understand that lack of vaccination can lead their children to contract more VPDs. People need to feel that their government is on their side and is not perpetrating Western or American plots and conspiracies. Rather than what we would call "reactive" coping strategies, Pakistan and other countries like it need "proactive" programs to improve vaccine uptake and to effectively deal with future challenges. COVID-19 has proven that we all live in a global community; thus, adequate health care is both a national and an international obligation.

DATA AVAILABILITY STATEMENT

The datasets presented in this article are not readily available because, The article not only draws on the current qualitative and confidential data but it also draws on our long-term ethnographic data that cannot be shared. Requests to access the datasets should be directed to inayat_qau@yahoo.com.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Pakistan's National Bioethics Committee (reference No.4-87/NBC-471-COVID-19-09/20/). Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

AUTHOR CONTRIBUTIONS

IA contributed to the conceptualization, writing the first draft, analysis, revision, and validation. SaA and SS contributed to the revision, analysis, and validation. ShA contributed to the data collection, revision, analysis, and validation.

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Alcohol Consumption and Perceptions of Health Risks During COVID-19: A Qualitative Study of Middle-Aged Women in South Australia

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Australian women's alcohol consumption has increased in frequency during COVID-19. Research suggests this is to cope with stress resulting from the pandemic and COVID-19 countermeasures that require social distancing. This is a critical public health concern because increased alcohol consumption, even for a short period, increases the myriad longer-term health risks associated with cumulative exposure to alcohol. This paper provides unique qualitative evidence of how health risk perceptions are re-focused toward the shorter-term during the pandemic, through analysis of interviews with 40 middle-aged Australian women (aged 45–64) representing a range of self-perceived drinking status' ("occasional"/"light"/"moderate"/"heavy") before and then during the pandemic (*n* = 80 interviews). Our analysis captures women's risk horizons drifting away from the uncertain longer-term during COVID-19, toward the immediate need to "get through" the pandemic. We show how COVID-19 has increased the perceived value of consuming alcohol among women, particularly when weighed up against the social and emotional "costs" of reducing consumption. Our findings have implications for the delivery of alcohol-related health risk messages designed for middle-aged women both during, and into the recovery phases of the pandemic, who already consume more alcohol and experience more alcohol-related health risk than women in other age groups.

Keywords: alcohol, women, middle-aged, pandemic, risk, breast cancer

INTRODUCTION

Women in midlife (aged between 45 and 64 years) typically consume alcohol more than any other age group (1) and alcohol intake, in addition to age, is associated with increased risk for various long-term health issues (1). Consequently, a critical public health concern follows from recent data demonstrating that Australian women have increased their frequency of alcohol consumption (number of days since the last drink) since the acknowledged emergence of COVID-19 in Australia in March 2020 (2). Discussion surrounding the impacts of

COVID-19 on health, and social issues more broadly, would suggest that the increased frequency of alcohol consumption is a gendered issue, with women feeling the effects of the pandemic in different and more pronounced ways relative to men (3). National survey data show that women report different reasons for increases in alcohol consumption than men (2). In their study of the impacts of COVID-19, Biddle et al. (4) found a negative relationship between mental health and alcohol generally, and relative to men, Australian women have experienced greater mental health instability during COVID-19 (5). Feeling stress is the most common reason women provided for their increased alcohol consumption during COVID-19 (2). Of compounding concern is survey data that shows loneliness is the most common personal stressor experienced during COVID-19, with Australian women more likely than men to report feeling lonely (4, 6). This is worrisome given our previous research which showed women typically consume alcohol to cope with loneliness and unhappiness, and to reduce stress (7, 8).

Myriad compounding factors have increased mental health instability for women during lockdown conditions. Due to the pandemic, women have spent more time at home and this is associated with numerous and significant gendered stressors. Relative to men, women experienced greater increases in caring responsibilities and unpaid work during COVID-19 (5, 9). For women aged 45–64 years (our study population) this translated to working from home alongside "juggling" support for older children in the later stages of school or enrolled in university and care for elderly relatives. While "stay at home" messages are clearly important during the pandemic, home cannot be taken-for-granted as a "safe haven." Home is not always a calm or safe space for women, as is represented in the increased incidence of domestic violence (10) and increased self-reported experience of isolation (4). The unequal gendered impacts on women resulting from COVID-19 also extends to their participation in the paid labour force. More women have lost their jobs during COVID-19 than have men, reflecting the disproportionate representation of women employed casually and in industries adversely affected by COVID-19 countermeasures (e.g., hospitality and tourism), resulting in a "pink-collar" recession. Furthermore, the largest fall in hours of paid work was experienced by women because, more so than men, they are employed on a casual basis and in industries where most job losses occurred due to social distancing measures (hospitality, education, and tourism). Additionally, more women than men comprise the Australian health and caregiver workforce (11) and, as such, face disproportionate stress associated with working on the "frontline" during the crisis.

As the pandemic unfolded in Australia, it became evident that measures to abate the spread of COVID-19 entailed unprecedented change in the practise of everyday living. In consideration of the unique gendered effects on women, it is anticipated that COVID-19 countermeasures have and will continue to augment the perceived value of consuming alcohol in women's lives. This paper presents timely insights into how middle-aged women (45–64 years of age) in South Australia describe their perceptions of alcohol-related health risks (and health risks more generally) during the COVID-19 pandemic compared to before the pandemic. The original focus of our

TABLE 1 | Sample characteristics by self-perceived alcohol consumption.

Self-perceived drinking status	Interviewed
Occasional drinker	5
Light drinker	15
Moderate drinker	15
Heavy drinker	5

Self-perceived drinking status was identified through responses to a participant survey conducted before COVID-19.

research (before COVID-19), was to understand the role of alcohol in women's lives and the extent to which breast cancer risk is factored into consumption. Alcohol is a class 1 carcinogen, which means that the ability for alcohol to cause cancer is certain, and it is an important modifiable cause of breast cancer (8, 12–17). The timing of the pandemic relative to initial interview data collection provided the opportunity to follow-up women previously interviewed about their consumption of alcohol and reasons for consuming alcohol during pandemic "lockdown."

This type of enquiry is indispensable because we know that the calculability of risk is compromised when the future is incalculable; and in turn negatively affects the relevance of future-oriented public health messaging (18). In so far as alcohol is concerned, we know that the uptake of alcohol risk-based messaging (e.g., reduce and consume at recommended levels) hinges on women's evaluation of scientific evidence weighed up against their "lay" health knowledge and experiences (19–21). This knowledge creates a theory of disease causality that has influence on women's reasons for continuing or modifying alcohol consumption (8). Our insights on the effect of the pandemic on women's alcohol consumption and health risk perceptions are crucial for future risk messaging both during COVID-19 and into the recovery phases of the pandemic.

METHOD

A study exploring women's lay knowledge of alcohol and breast cancer risk was undertaken between July and December 2019. This involved interviews with 51 English speaking middle-aged (45–64 years) South Australian women of mainly Anglo-Saxon ethnicity (by researchers KF and BL) who identified reasons for alcohol consumption and understanding of breast cancer risk before COVID-19 emerged in Australia. Women were purposively sampled to vary in alcohol consumption by "self-perceived drinking status" to capture "occasional," "light," "moderate," and "heavy" drinkers across a cross-section of ages (comprising the 45–64 demographic bracket) income levels and education. Self-perceived alcohol consumption was used given our study focus being to understand the functions and meanings of alcohol consumption relative to women's own perceived breast cancer risk. Our sampling strategy involved purposeful selection of mostly self-perceived "light" and "moderate drinkers," and "extreme" case sampling (22) of some "occasional" and "heavy" drinkers for variation (see **Table 1**). Sampling continued until saturation was reached (23, 24). During COVID-19 (March to

April 2020) follow-up interviews were conducted with 40 of the initial 51 participants, with the aim to explore the impact of the significant health risk and life challenges faced in the pandemic on their alcohol consumption and risk perceptions. For the purposes of this paper, we are not examining any differences in women's responses by demographic grouping, as our focus is on drinking status in so far as to achieve an understanding of if and/or how the pandemic has impacted alcohol-related health risk perceptions.

Before COVID-19, interviews explored women's perceived associations between alcohol and breast cancer risk specifically. Women's "lay expertise" around rationalities for consuming alcohol were explored, particularly as they related to evaluation of longer-term health risks, using breast cancer as the example of an outcome to be avoided. We also explored participant–driven explanations for alcohol consumption, and justifications of the evidence used for the belief (or not) that alcohol is a modifiable risk factor for breast cancer, including trust in different sources of evidence and risk messaging. Finally, barriers and enablers to intake modification were examined and their relationship to potential risks. At follow-up interviews during COVID-19 participants were asked if social distancing rules changed how they socialised or connected with others, and in what ways. Social distancing rules to prevent the spread of COVID-19 resulted in restrictions on public activities and were implemented by the South Australian Government in March 2020 and were gradually easing by October 2020.[1] Different states and territories of Australia experienced the pandemic differently and accordingly, Government responses varied by locality. The impacts of social distancing on participant's alcohol consumption, if they had stockpiled alcohol, whether the reasons why they consume alcohol had changed and if any changes in consumption patterns had occurred during COVID-19 were also discussed. Finally, participants were asked whether their perceptions of risk had changed and about possible shifts in their balancing of long term vs. short terms harms and gains. The complete interview schedule can be requested from the corresponding author.

The two waves of interviews (before and during COVID-19) were conducted slightly differently due to the social distancing conditions experienced during COVID-19. Interviews conducted before COVID-19 were ~1 h long and in person by the researchers KF and BL (both female and experienced in interviewing) in participant's homes, cafes or community centres, public libraries, whatever was preferred by the participant. The interview followed a schedule, with the researcher probing for further detail on women's thinking, logic and perspectives regarding alcohol and breast cancer. It was emphasised that there were no incorrect answers to any of the questions asked and this supported rapport-building during the interview. The researcher approached the interviews with "empathic neutrality" (22) and worked hard to avoid moralising any information women contributed. Participants were not sent the interview schedule prior to the interview, because in this wave of interviews we wanted to explore women's lay knowledge about alcohol

and breast cancer. We hypothesised that sending them the schedule might encourage them to view the interview more formally and research the link between alcohol and breast cancer prior to the interview. The follow-up interviews conducted during COVID-19 lasted 30–45 min and were undertaken by researcher BL over the telephone or via tele/videoconference applications (as per social distancing rules) following a semi-structured schedule. Participants were emailed to establish an interview time and preferred mode of communication. In these follow-up interviews, women were sent the schedule prior to the interview (1–2 days ahead) to allow time for reflection before they provided a response, and as not to cause undue pressure during the crisis.

All interviews were audio-recorded, transcribed, and then wave 1 and wave 2 transcriptions from each participant were matched and de-identified (pseudonyms are used in this paper). Once matched, transcripts were analysed cross-sectionally at both time points and then across time, providing the capacity to identify any changes in participant's alcohol-related risk perceptions across time and how these might be linked to the experience of COVID-19. This approach also allowed exploration of the impact of policies and regulations implemented to stem the spread of COVID-19 (i.e., pandemic countermeasures) (25).

Data were managed using QSR NVivo version 12 qualitative data analysis software (26). Cross-sectional analysis followed a three-step progressive method of (1) pre-coding, (2) conceptual and thematic categorisation and (3) theoretical categorisation (27). To check for agreement in coding and improve explanatory rigor the researchers BL, KF, MW, JT and PW each co-coded four transcript pairs comprising interviews conducted before COVID-19 (wave 1) and during COVID-19 (wave 2) per participant; one pair from each category of self-perceived drinking status: "occasional," "light," "moderate," and "heavy." Once agreement was reached on codes comprising the coding framework – a process that achieved interpretative validity - transcripts were deductively coded against the agreed coding framework and new codes were added as they emerged through analysis following a framework analysis approach (28). Data were then organised by theme into time-ordered, sequential matrices to facilitate comparison of women's reasons and logic for alcohol consumption before COVID-19 with their descriptions of behaviour during COVID-19 and in responses to public health messaging. Analysis focused on how the thematically grouped data in each set of paired transcripts changed or remained stable over time (29) and on the conditions, causes and consequences of change (30, 31). This allowed us to detect patterns of change or where previous risk perspectives were substantiated in participant's interview responses across time, within themes such as precursors of alcohol consumption and participant's experiences; risk perceptions and shifts away from longer-term health risks toward shorter-term outcomes or where the pandemic solidified or confirmed a participant's pre-existing short-term focus.

Both waves of interviews and associated protocols had full ethical approval from the Social Behavioural and Human Research Ethics Committee at Flinders University, South Australia.

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[1]See: https://www.covid-19.sa.gov.au/response.

RESULTS

Our results explicate women's perceptions of alcohol-related health risks before and during COVID-19 and show the pandemic shortened most women's risk horizon toward the more predictable short-term. The perceived need to "get through the pandemic" impacted on intended alcohol consumption, particularly when weighed up against the social and emotional "costs" of reducing consumption. Before we present comparisons, it is necessary to first summarise women's risk perceptions described when we interviewed participants before COVID-19. Importantly, for many women it seemed possible to contemplate reducing or even begin to make reductions in their alcohol consumption. We then integrate data from interviews undertaken during COVID-19. In several cases we compare these to responses before COVID-19, to demonstrate how perceptions of risk were re-focused to the more predictable short-term amidst the pandemic and negated previous possibilities for alcohol reduction. Re-interviewing women provided data that described how changed life circumstances impacted women's rationalizations of alcohol consumption, particularly as they related to evaluation of known health risks. For participants of our study, such changes were work-related - generally this included a reduced sense of work satisfaction (through isolation), increased pressure at work and in some cases, a sense of job insecurity (at the time of interviews no participant had been stood down from work). Various women's caring role of older parents increased, although some experienced restricted access to elderly or unwell parents. Several participants needed to increase the care they provided their children with additional needs due to support service shut-downs. Retired participants who typically looked after (and enjoyed looking after) their grandchildren became isolated from them. Such participants also experienced reduced volunteering opportunities and subsequently, a reduced sense of purpose. Many women talked about feeling increased pressure to source and provide food for others in the home (an extension of their care role) and having sole responsibility for maintaining the domestic space. While women in our sample who had children mostly parented older children, they spoke about needing to manage disruptions to their children's vocations and some talked about their children either returning home to live or being isolated because they were staying with a partner and were unable to move between houses due to distancing rules. Many women spoke about gym closures and reductions in personal training/boot camps which adversely impacted their sense of connectedness with the community and their health/well-being, and their weight. As can be seen by this extensive albeit not exhaustive overview, the magnitude and implications of change obviously varied across the sample, yet no participant's life circumstances were unaffected by COVID-19. In our results we also include data to show how "other" risks emerged alongside the pandemic that took precedence over any considerations of longer-term alcohol-related risk. For some women, the pandemic provided "evidence" that substantiated their pre-existing short-term or even fatalistic philosophy (i.e., "life is short" "anything can happen" and accordingly we should

"live in and for the moment"). Several women were already leading limited lives economically and socially that necessitated a short-term focus before COVID-19 emerged and the pandemic ensued little change. The final section of our results shows how women questioned the sustainability of change required for longer-term health risk reduction and in the context of "other" risks perceived as more urgent.

Perceptions of Alcohol-Related Health Risk Before the Pandemic

Interview data collected before COVID-19 indicated that critical distinctions were made between women about the link between alcohol consumption and breast cancer risk. Such distinctions included differentiated reasons and rationalities for alcohol consumption that linked to women's "lay knowledge" of what causes breast cancer and their perceptions of their own breast cancer risk. Interviews also indicated two prevailing decision dilemmas. The first focused on women deciding on whether they were *willing* to reduce consumption and the second involved their assessment of the *feasibility* of achieving this goal. Most participants could make sense of scientific information about the negative impact of alcohol on health and, before COVID-19, acknowledged it as a risk factor for breast cancer. Notwithstanding this, women rationalised consumption according to a range of social, cultural, financial and emotional considerations (8). Some women expressed willingness to consider reducing alcohol consumption and described self-directed measures to reduce or moderate their alcohol intake (such as keeping drinking diaries, creating rules that permitted drinking alcohol only on certain days, and so on). The COVID-19 pandemic, and the associated social distancing and home-based isolation designed to drive down COVID-19 case numbers, created a massive change to the way participants lived their daily lives. These changes impacted women's feelings about the feasibility of reducing alcohol consumption and seemed to justify continued consumption. For participants who contemplated reducing alcohol consumption with the view of reducing breast cancer risk, COVID-19 had a negative effect. Further detail on views of women's logic in navigating alcohol-related breast cancer risk can be found elsewhere (8).

Shifting Risk Perceptions Toward the Short-Term During COVID-19

In terms of risk-based decisions, the ambiguity experienced during "pandemic life" seemed to curtail participants' longer-term concerns. Positive feelings gained from drinking alcohol justified consumption. That is, relative to the certainty and immediate relevance of adapting and responding to public health guidance and "survive the crisis," the value of consuming alcohol as a coping mechanism took precedence when held up against the *possibility* of health risks. One participant rationalised consuming alcohol by detailing the positive impact on mood gained from drinking; *"there is no point being alive if you're miserable"* (Rebecca, aged 47, moderate drinker, during COVID-19, partnered, no children). In fact, when asked about longer-term risks, most women saw this as of only minor concern;

"*when you take a whole picture of life one glass of wine seems insignificant*" (Tricia, age 59, light-drinker, during COVID-19, divorced, children). The prominence of participant's concerns before COVID-19 about longer-term health risk (using breast cancer as an example) was also reduced by the experience of the pandemic and replaced by the more pressing concerns of vulnerability to the virus. For example, before COVID-19 Joy suggested she would be willing to follow guidelines about levels of alcohol consumption for health risk reduction, using the example of breast cancer risk reduction, she said:

"*If you're going to tell me that I'm going to get breast cancer from the next rum I have, then I'm probably not going to have the next rum*" (Joy, aged 50, moderate drinker, divorced, one child, before COVID-19).

In contrast, during the pandemic, Joy's risk perspective was re-focused away from the longer-term risks (i.e., breast cancer risk) toward the "immediate concern" of getting through the pandemic. This was pronounced for her due to pre-existing health conditions that would be co-morbidities if she contracted COVID-19. For example:

"*My immediate concern is obviously what's going on because I'm in that high-risk group [for COVID-19]. So, things like breast cancer and things like that they've sort of been put on the back burner, if that makes any sense. I'm sort of at this point where I'll get through this and then I'll worry about that [alcohol consumption]*" (Joy, aged 50, moderate drinker, divorced, one child, during COVID-19).

Other participants did not discount their knowledge that alcohol consumption impacts longer-term health risk, using the example of breast cancer risk. Nonetheless, the time horizon of their health decisions was adjusted in response to the crisis, to focus on the current pandemic demands and threats. During COVID-19 participants were exposed to a new and pressing health risk; a contagious and life-threatening virus and this became an equivalent or more dominant focus. For example, Stephanie contemplated reducing consumption with the view of protecting herself from illness before COVID-19. When asked before COVID-19 how she thought she could reduce her risk of illness (specifically breast cancer), she responded:

"*probably cutting down on drinking alcohol, well, I already have but I had been thinking about giving it up completely*" (Stephanie age 48, light drinker, divorced, no children, before COVID-19).

During COVID-19 however her previous consideration given to reducing alcohol consumption was expanded to also include immediate concerns and ways to prevent contracting SARS-Cov-2:

"*I haven't thought any more about breast cancer. I did think about alcohol and the relationship between alcohol and a whole range of things; breast cancer's one of them but then other cancers, colon cancer, whatever, and even kidney stones; you're meant to be drinking lots of water and alcohol is not good for it. But I'm certainly thinking about the risk of COVID-19 and where I go and*

I've got my hand sanitiser and I'm washing my hands and things like that" (Stephanie, age 48, light drinker, divorced, no children, during COVID-19).

Several participants described reducing consumption during COVID-19 – but this was not motivated by health risk reduction, but rather by maintaining or bolstering their ability to cope during the pandemic. For example, Alex, who through COVID-19 worked from home and felt shut off from her colleagues explained:

"*I didn't see that as a response that I would drink more but I thought it was better if I was actually drinking less, I'd be healthier and less anxious and it would be better for my mental health if I really restricted alcohol, so, I didn't see that I would be drinking more wine, I just thought I need to drink less during this time*" (Alex, aged 64, moderate drinker, partnered, children, during COVID-19).

In this instance, the acute nature of viral risk resulted in a change in alcohol consumption, whereas before COVID-19 when asked about if breast cancer risk and reducing alcohol consumption was on her radar Alex's response showed reduction as a possibility, though notably this was not actioned:

"*it certainly was prominent in my thinking about if I'm drinking in a risky way I need to cut that back. Like I've seen people go through chemo and radiation therapy and it's not something I fancy so if I can not be smoking as a risk factor for lung cancer I can cut back my drinking to a degree as a reduction of risk factor for getting breast cancer, for instance.*" (Alex, aged 64, moderate drinker, partnered, children, before COVID-19).

Other participants spoke about *intentions* to limit alcohol consumption to improve their physical health, but the rationale was physical fitness to withstand the COVID-19 virus rather than for breast cancer considerations. For example:

"*There's a link between wanting to be fit so that if I got the virus I start from a good place and then kind of drinking that in and going in long term I want to be fit and this –obviously there are things in the world that can kill me that I have no control over and some of those are cancer*" (Anna, aged 46, moderate drinker, married, children, during COVID-19).

For some participants, the notion of risk as a broad consideration, not necessarily focused on health, intensified during COVID-19 and this seemed to manifest in more frequent alcohol consumption. For example, women described risks to maintaining work outputs despite pandemic impacts. For example, before COVID-19 Nadia, a self-perceived light drinker explained:

"*The one thing I like to do each day when I get home is separate that work from my time so I'll have one beer. Generally I try and have two alcohol free days a week, completely, but I'll, probably three or four nights of the week, have just that one beer and that's it; that's all I have and don't touch anything else*" (Nadia, aged 49, light drinker, separated, children, before COVID-19).

During COVID-19, Nadia's alcohol-free days disappeared:

"So, I guess I'm kind of playing that off and rewarding myself, and saying, well, you can have a drink each day....so definitely more consumption, but obviously less socializing and going out doing that." (Nadia, aged 49, light drinker, separated, children, during COVID-19).

During COVID-19, participants' responses to probes about alcohol-related risks highlighted that hard times make it difficult to focus on longer-term possibilities. During COVID-19, women provided explanations like the following:

"[people are] focused on solving the immediate issue" (Donna, aged 60, occasional drinker, living alone, no children, during COVID-19).

Another example is:

"I think it's just really focused in on the here and now, rather than the longer-term of anything, really" (Paula, aged 48, light drinker, married, children, during COVID-19).

It was clear from several participants' accounts of the all-consuming nature of existence through the pandemic (including processing news, deciphering public health information, coordinating and adapting to new ways of living), that little headspace was left for comprehending longer-term health risks. This shaped participants' orientation toward the immediate future, for example:

"I don't think I feel shock, but I just feel this is a whole new thing and it is weird, and I think it's quite hard to get your head around. I think that probably slows people down in taking preventative measures that they should be taking" (Lois, aged 60, moderate drinker, married, children, during COVID-19).

One participant did discuss her continued awareness of the longer-term impact of her behaviours through COVID-19 but moored this in concerns for reducing the burden on the health system. She said:

"But when you do talk to people – what's the one thing everybody talks about? They just talk about this – the COVID-19. So it feels like the whole world is in limbo, waiting for something. I think we're just all going through the motions just waiting for it to be over. There probably is no room [to think about breast cancer risk]. And it's like, while this is going on, it's like you don't want to get sick with anything else, because you don't know what the health care system is going through at the moment. Is the health care system overwhelmed? (Tiffany, aged 53, moderate drinker, living alone, no children, during COVID-19).

Tiffany's comment about there being "no room" to contemplate breast cancer risk again points to the difficulty comprehending longer-term risks in the frame of pandemic health risks:

"You feel like, well, I don't really want to get sick with anything else, because it's probably going to be too hard to try to get treatment for

anything else" (Tiffany, aged 53, moderate drinker, living alone, no children, during COVID-19).

Many of the women we interviewed described having no coherent view of the longer-term future during COVID-19, and expressed feeling "in limbo," waiting to see how the virus "played out," including determining how public health responses to COVID-19 could impact their life. This climate of uncertainty not only changed women's feelings about the feasibility of reducing alcohol consumption, but adversely affected their willingness to make modifications. Conversely, during COVID-19 women were able to describe the myriad "good things" they gained from consuming alcohol; relief from stress or boredom, reward for coping, retaining a sense of normality, and facilitating a sense of connection with others through the shared activity of drinking alcohol or through using alcohol consumption as a talking point.

The Emergence of Other Risks During the Pandemic: Reduced Attention on Alcohol-Related Risks

Many participants indicated that concerns about other people's health risk took precedence over worry about their own health, and concern about managing any longer-term alcohol-related health risks. This concern was primarily for elderly parents and loved ones working in occupations involving close contact with others during the pandemic. The following excerpt captures how priorities around risk were not about personal risk but risks to others, and the risk of not being able to help:

"I don't think it's made me think any differently about any risks really to myself, it's more if something happened to Mum and she's over there all by herself is probably more a bit of a thing where in the past I've just thought, well, if something happened to mum, well I would jump in the car and drive her which I can still do but if, you know, more lockdown business happens and I couldn't then I haven't quite figured my way through that one...So it's probably more thinking about from her point of view, from my point of view thinking about her and what would happen if it got any worse or if something happened to her rather than myself. I don't think anything would happen to me" (Trudy, aged 60, moderate drinker, widowed, no children, during COVID-19).

Additionally, several participants discussed the moral aspects of risk, describing the need to be "seen to be doing the right thing." For example:

"to me it's a matter of doing the right thing to be not seen out so that other people don't go out....the risk is not about me getting it [COVID-19], the risk is about doing the right thing in terms of staying away from people" (Gillian, aged 51, light drinker, married, no children, during COVID-19).

One participant seemed unable to comprehend risks outside of those imposed by the SARS-CoV-2 virus resulting in the COVID-19 pandemic. This participant interpreted our question on perceptions of alcohol-related health risk during COVID-19 only in the context of the virus, perhaps demonstrating the

pervasiveness of viral risk messaging and/or her "blinkered" approach to longer-term health risk. When asked about how COVID-19 had impacted and made her feel about her health she replied:

> "*I am conscious about more hand washing, social distancing, disinfecting the trolley once I get that and all little things. It's a bit scary to go to the supermarket these days*" (Tamara, aged 45, moderate drinker, divorced, children, during COVID-19).

Another participant countered the link between alcohol and longer-term health risks, and rationalised consumption as improving health through COVID-19 by "*easing stress and improving sleep*" (Mary, age 64, moderate drinker, separated, no children, during COVID-19); two factors she believed compromised health substantially and that if improved, would bolster her resistance to the virus and increase her overall longevity.

Pre-existing Short-Term Focus Substantiated During the Pandemic

Not all women's perception of risk was open to a shift. For some women, the pandemic substantiated their pre-existing preference or need to focus on the present time. Others already lead lives characterised by economic challenges and/or social restrictions, and for them the pandemic provided no change to the previous necessity to focus on "getting through" the difficult short-term. For example, before COVID-19, one participant referred to the "lottery" of health outcomes and rationalised alcohol consumption accordingly. This became consistent both before and during COVID-19, and living through the pandemic confirmed for her that:

> "*it's a bit of a lottery really, your health, isn't it? You need to be mindful of doing the right thing, and if you're doing some things like drinking alcohol, it's seen as a bad thing, and you enjoy it, then moderation hopefully it will be okay*" (Kimberly, aged 62, moderate drinker, married, children, during COVID-19).

Another participant, in a fatalistic sense, suggested that her perceptions of the probability of longer-term ill health have increased because of COVID-19:

> "*I think it [COVID-19] probably has heightened your awareness of the fact that you could get other illnesses or disease as well but that's about as far as it goes with me. I think it just highlights the fact that anything can happen health wise*" (Lois, aged 60, moderate drinker, married, children, during COVID-19).

Where the time horizon that impacted decision-making and alcohol consumption changed after COVID-19; the focus was on meeting immediate needs, be they caring for themselves or others:

> *I think it [COVID-19] shows you life is short and just enjoy what you can while you have got your [virus-free] health sort of thing*" (Harriette, age 55, heavy drinker, married, children, during COVID-19).

This excerpt also reflects a "live for the here and now" philosophy that was echoed by many women interviewed during COVID-19, and for many women interviewed, this involved consuming alcohol at before COVID-19 levels or more frequently.

For some of the women who participated in our study, life circumstances before COVID-19 were already characterised by persistent unease. For women like this, the pandemic had little influence on their alcohol consumption and perceptions of alcohol-related risk. For example, while one participant stated during COVID-19 "*I can tell you my own mortality has surfaced*" (Michelle, age 56, heavy drinker, married, children, during COVID-19) which resulted in "*short-term thinking,*" in terms of her health risk perceptions, nothing changed as a result of COVID-19. There were simply no shifts for her, given before COVID-19 she said with aplomb "*I'm so far down the rabbit hole of risk*" (Michelle, age 56, heavy drinker, married, children, before COVID-19), and she described feeling unable to navigate back out, and that alcohol consumption was a strategy for managing this feeling. Before COVID-19 emerged in Australia, Michelle described feeling "*held hostage by alcohol*" and it seemed that alcohol consumption is so engrained as a way of life, any potential risk is innate and modifying consumption is outside of her control. In this instance, recognizing the physical health risk of consuming alcohol was not enough to motivate reduction.

Sustainability of Change Required to Reduce Alcohol Consumption and Impacts on Risk Prevention

Before COVID-19, participants spoke about the changes that would be required for them to reduce alcohol-related health risks, and during COVID-19 these became, in participant's words "*too much*" time and accepted as too challenging. The comparatively immediate and less complex routines required to prevent viral transmission (e.g., practising distancing, hand washing) were deemed less problematic as most women envisaged the virus soon disappearing. In fact, commitment to willingness and evaluation of the feasibility of preventing COVID-19 contrasted vividly with the difficulty of reducing breast cancer risk. In the following explanation a participant juxtaposes the complexity of change required to reduce alcohol-related risks with the simplicity of COVID-19 prevention:

> "*Because it's just basically, if I self-isolate I'm safe. So, I just have to do one thing, really. Whereas with breast cancer, it's a multi-layered approach to risk…but [for COVID-19] it's really – it's just some things that I just have to think about and it doesn't impact my lifestyle, you know? It doesn't take away from my life. So that's the difference is, I think, is that yes, I can do this for say, three months if I need to, but I couldn't do it for three years. That's just not going to happen*" (Rebecca, aged 47, moderate drinker, partnered, no children, during COVID-19).

This participant's explanation also captures how consideration is given to the relative difficulty of short vs. longer-term changes. The costs to lifestyle of breast cancer risk management appear to outweigh the investment of time required to practise health prolonging activities. For some participants,

the time commitment required to reduce alcohol consumption to reduce longer-term health risks were considered *"too long to go for"* and therefore dismissed as unachievable. As the following participant explained, the risk message is subsequently ignored:

> *"I don't think about the risk [of breast cancer] I put it to the back of my mind and carry on regardless, I still don't put enough emphasis on that connection and its bad, I know it's bad but I can't explain why because I figure that alcohol, the risk of alcohol can be damaging any part of you, not just the breast cancer connection you know. So, if I worry about breast cancer, I've got to worry about.... it's like If I don't think about it then it's not going to hurt me so I won't stress about it and if it happens it happens…so it's almost like worry about what's happening right now and worry about the things you can actually control if you know the dangers"* (Danielle, aged 46, light drinker, separated, children, during COVID-19).

Earlier we explained how participant Anna (a self-perceived moderate drinker before COVID-19) focused her risk perceptions on the short-term virus prevention, not alcohol-related health outcomes. She later clarified that her intentions to reduce consumption during COVID-19 and focus on health resulted in moments of overwhelm and ultimately denial:

> *"So, probably that – when you go, well, or you're a bit anxious about what's going on, and then, you know, put your health into focus, then the flow-on effect of that is that every now and then is, "I've had enough, I just want to – I just want to relax and remember what it's like when I don't have to worry about these things. So, that's when alcohol is probably brought in"* (Anna, aged 46, moderate drinker, married, children, during COVID-19).

Several participants' curiosity about reducing their alcohol consumption before COVID-19, found that motivation was quashed during the pandemic. This is captured through our interview with Danielle who was preparing to reduce her alcohol consumption by researching her risk levels before COVID-19:

> *"I actually did a web search to see what I could do if I wanted to reduce the amount of drinking and then I come across this website in the UK and it actually got you to put in just some basic details, you know, age group and sex and all that sort of thing, to see if they consider your drinking unsafe and I was"* (Danielle, aged 46, light drinker, separated, children, before COVID-19).

However, during the pandemic, she explained that any plans to reduce consumption were on hold due to anxiety associated with COVID-19:

> *"I have done (thought about the risks of drinking) but certainly not while this is going on [COVID-19] while this is going on I'm just going to continue to behave as normally as possible…so I'm not in that anxious state I'm just going to keep doing…I've been trying to behave as normally as possible to beat the potential [COVID-19] anxiety"* (Danielle, aged 46, light drinker, separated, children, during COVID-19).

DISCUSSION: RELEVANCE AND IMPLICATIONS FOR RISK MESSAGING

The COVID-19 pandemic has highlighted that Australian women's alcohol consumption and perceptions of health risk are shaped by social practises across a range of life circumstances – economic, social, cultural, and emotional. Many participants in our study, who consumed alcohol prior to COVID-19, rationalised their consumption in new ways in terms of risk and according to the demands of the immediate situation during COVID-19. In other words, context, which included the presence of COVID-19 in the community, and the associated lockdown and social distancing requirements, defined the short-term context in which the decision to consume was made. COVID-19 created great uncertainty for many Australians. As uncertainty is exacerbated, achieving a sense of personal control might increasingly involve focus on coping with difficulties in the here and now. Consequently, alcohol consumption might be influenced by pragmatic considerations including the management of acute needs. Our results suggest that times of crisis, like the COVID-19 pandemic, orientates women toward the demand of the immediate future. This involves assessing and responding to more urgent, daily probabilities, where risk perceptions are refocused on the "short horizon" (18). The women we interviewed during COVID-19 described having developed a reduced "headspace" for consideration of long-term health risks, including acting on the association between alcohol consumption and breast cancer risk (as an example of a longer-term health risk linked to alcohol consumption). Here we are reminded of Beck's "eschatological ecofatalism" (32) to describe how the constant uncertainty experienced through COVID-19 and feeling of no certainty, and of avoiding "danger," might result in women "pulling the shutters down" to risk and avoid contemplating risk altogether (33). We are also reminded of the dichotomous, "good/bad" tensions within coping strategies that allow immediacy in allowing relief during adversity – a sense of "doing what it takes" to get through the difficult short-term albeit compromising longer-term health outcomes (34).

The inverse relationship between perceived benefit and perceived risk of an action whereby people judge a risk not only by what they think about it but how they feel about it (35) has relevance for how we might understand women's weighing up of the costs and benefits of alcohol consumption during COVID-19. It is clear in our interview data collected during COVID-19 compared to women's responses before the pandemic, that the feelings women experience amidst COVID-19 provide "information" on which judgements about risk should/do inform decision-making. It is also likely difficult for women to see this as problematic given the extent to which alcohol is embedded in the social fabric of Australian society and considering norms that tell women consuming it is a normal, socially acceptable coping mechanism. This is crucial for the delivery of health risk messaging during COVID-19, and any times of crisis – it is futile to tell women about the longer-term health risks of alcohol while they are

preoccupied with simply "getting through" and the associated immediate needs. Leverage in alcohol-related health promotion will have more potential if there is acknowledgment of how consumption behaviours are shaped by, and integrated within, women's daily living, which is naturally tied to their ongoing and dynamic perceptions of risk. It must be acknowledged that monitoring personal alcohol consumption is challenging whilst surrounded by alcohol product marketing that targets women (36), living in an environment where alcohol remains readily available during COVID-19 lockdown (37) (e.g., liquor stores remained open albeit with some restrictions including volume limits on purchases and limited gatherings in licenced premises), and where consuming alcohol is marketed as a socially acceptable way to manage day-to-day stress during the pandemic[2] and to celebrate the lifting of restrictions (38). As we have noted elsewhere (8), women's appraisal of their own alcohol-related health risk culminates from information brought together through personal, social, and cultural sources.

Our findings also demonstrate that different women have been impacted differently by COVID-19, in terms of their alcohol-related risk perceptions, and seem to be linked to their life circumstances before but also during COVID-19 (according to the impact of the pandemic). The "collective struggle" to adapt and modify our lives has been necessary to "flatten the epidemiological curve." However, population level distancing measures to lower mean risk levels have entailed different modifications for different groups of women. Existing social and economic vulnerabilities mean personal costs and private misfortunes are amplified through pandemic countermeasures (39, 40), in turn affecting possibilities to reduce alcohol consumption. This has been made visible through our discussions with women that show uncertainty with the possibility of inflating or solidifying risk perceptions was experienced by some women during COVID-19. Yet, our research also clarifies that for some women life during the pandemic resembles their already chaotic and unpredictable lives. It is likely that certain women have been, and will continue to be, disproportionately impacted economically, emotionally, socially by government requirements to socially distance during COVID-19, in turn impacting their alcohol-related decision-making differently relative to men (39). Of course, it must be acknowledged that our study recruited women of mainly Anglo-Saxon ethnicity and there are some limitations to the generalizability of our understandings reported here to the broader population of Australian women. We intend to undertake additional analyses that would differentiate women's responses by social class groups and achieve a more complete understanding of women's alcohol consumption and risk perceptions during COVID-19 according to demographics. This would allow insight to whether changes in perceptions of the risk of alcohol are impacted differently during COVID-19 depending on women's social class grouping. This would also enable theoretically-informed explanations of class-based experiences and contribute to understanding population-level

distributions of risk factors and perceptions amongst groups of women (41, 42). How this might translate to class-based alcohol-related risk communication is uncertain, though relevant and is worthwhile given we do not know the lasting effects of this pandemic and when the future is uncertain, future-oriented public health interventions that rely on individual action are limited. Beyond the immediate risk of contracting the virus, it is not clear what the prolonged social and economic impacts will be on well-being and the ongoing bearing on women's future alcohol consumption and overall perceptions of health risks. As Australia shifts focus toward the recovery phase of the COVID-19 pandemic and the future remains unclear, our findings have relevance for future public health approaches that respond to COVID-19. As countermeasures shift and change in response to the pandemic, women's responses, and ways of coping manifest through alcohol consumption, might change over time. Gendered policy responses are needed that consider the implications for risk messaging as experienced specifically by women, as a population group vulnerable to the unintended consequences of pandemic social distancing measures described herein.

CONCLUSION

This paper outlines to policy makers the impact of current and future COVID-19 interventions on women's alcohol consumption as well as their shifting perceptions of health risks. It is useful for planning future policy to mitigate the unintended consequence of pandemic responses in terms of links to increased alcohol consumption. For the South Australian women we interviewed, pandemic responses required focusing on surviving the "crisis" in the immediate future, a sense of doing whatever is required to get by, and the short-term gains of alcohol consumption in this context overshadow any longer-term health risks. By understanding this logic, we can identify strategies to change women's present alcohol consumption to potentially improve their health outcomes into the future. We can also recognise how individual health risks are moored within and contextualised by broader social structures that warrant policy consideration.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

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[2]For examples see: https://www.abc.net.au/news/2020-04-16/coronavirus-themed-alcohol-marketing-sparks-call-for-ban/1215191.

AUTHOR CONTRIBUTIONS

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Perceived Social Norms as Determinants of Adherence to Public Health Measures Related to COVID-19 in Bali, Indonesia

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Introduction: Before the widespread availability of an effective COVID-19 vaccine, it is crucial to control the rate of transmission by ensuring adherence to behavioral modifications, such as wearing masks, physical distancing, and washing hands, all of which can be implemented as public health measures. Focusing on the conditions in Bali, this study explored the level of compliance to public health measures targeted at COVID-19 and identified the determinants of compliance via the values, rules, and knowledge approach.

Materials and Methods: This cross-sectional study conducted an online survey using the Google Form application from June 29 to July 5, 2020. The minimum required sample size was 664. Inclusion criteria were set as follows: 18 years of age or older and residing in Bali during the data collection period. Adherence was measured based on nine protocol indicators that were rated using a four-point Likert scale. A multiple linear regression analysis was then conducted to determine the associated factors of adherence to public health measures.

Results: Of the 954 survey respondents, data from 743 were included for analysis. The average level of adherence to public health measures was 32.59 (range of 20–36). The linear regression analysis showed that perceived health benefits from public health measures, being female, and having COVID-19 test histories were significantly associated with adherence to public health measures.

Conclusions: For public health measures targeted at COVID-19, adherence was strongly associated with perceived social norms, in which individuals played social community roles by adapting to standardized public health measures. It is thus imperative for governments to support and monitor public health measures during the COVID-19 pandemic.

Keywords: COVID-19, social norm, prevention protocol, adherence, online survey

INTRODUCTION

Coronavirus disease (COVID-19) was first identified in Wuhan, China, on December 31, 2019. Due to the ease of transmission, it is now found across the globe. In fact, ∼71.4 million confirmed cases and 1.6 million deaths were attributed to COVID-19 as of December 13, 2020 (1). The pandemic has also caused a variety of social, political, and economic crises, some of which have resulted from the unintentional impacts of public health measures targeted at controlling the virus (2). The development of COVID-19 is still fluctuating in Indonesia. As of now, it is unclear whether the country has seen the peak of the pandemic, with the number of confirmed cases reaching 605,000 on December 13, 2020, including 18,511 deaths (3).

The World Health Organization (WHO) has suggested several public health measures for containing viral transmission. In this context, Indonesian policies for handling COVID-19 are implemented through health promotions, particularly those involving the implementation of clean and healthy lifestyles, social and physical distancing, mandates for studying and working at home, universal mask usage, screening, and large-scale social restrictions in areas that are undergoing significant increases in the number of cases (4–6). Although the COVID-19 pandemic has not yet peaked, the Indonesian nation plans to officially adapt to "the new normal" by the end of May. According to the Indonesian Department of Health, "the new normal" is defined as the widespread implementation of productive and safe community activities that adhere to COVID-19 prevention measures, including mandatory mask usage, safe social distancing, the practice of always washing hands with soap and running water, regular exercise, adequate rest, the avoidance of panic, and nutritious diets (7). These adaptations were initially made based on epidemiological indicators of the reproduction number (R0) associated with the pandemic and limited to certain sectors (8). While most regions in Indonesia have officially declared their intent to adapt to the new normal, many locations have not yet met the epidemiological indicators; some have even seen increases in the number of cases.

Various factors are required to ensure an effective adaptation process, which is facilitated when individuals have sufficient knowledge about newly introduced habits. Research related to community knowledge, attitudes, and behavior toward social distancing policy as a means of preventing transmission of COVID-19 in Indonesia showed that 99, 59, and 93% of respondents have good knowledge, positive attitudes, and good behavior toward social distancing, respectively. Among the respondents who had good knowledge, 58.85% showed positive attitudes, and 93.3% have good behavior. The vast majority of the respondents who had positive attitudes showed good behavior (96.7%) (9). The knowledge, attitudes, and practices of using masks by the community are efficient in the prevention of the spread of COVID-19 infection (10). Knowledge, attitudes, and practices (KAP) toward COVID-19 play pivotal roles in assessing the willingness of a community to adopt behavioral change initiatives during the pandemic (11). This is associated with a better understanding of the related values and benefits, which are supported by regulations that encourage the implementation of both formal and informal behaviors (e.g., social pressures resulting from observed behaviors or adaptations made by others) (12, 13). This study examined the level of adherence to these types of adaptations in Bali, specifically those targeted at achieving the new normal through COVID-19 prevention measures. This investigation was accomplished via the values, rules, and knowledge (VRK) approach, which can later be structured into an improved adaptation strategy.

MATERIALS AND METHODS

Study Design and Setting

This study conducted an online cross-sectional survey using the Google Form application from June 29 to July 5, 2020. The required sample size was calculated using the survey formula, based on the 99% confidence interval (CI), 0.50 proportion of adherence, and 0.05 precision, the minimum required size was 664 respondents. This study used the 99% confidence level in the sample calculation to increase the chances of getting a reliable sample of the population parameters if the estimation process is carried out repeatedly and minimizes the risk of error results obtained from the sample. We invited respondents through a Google link form listed on a poster showing information about the study purpose, which was shared via both Facebook and WhatsApp. Poster then shared through researcher's networking and social media influencers. Eligibility criteria were set as follows: aged 18 years or older, residing in Bali during the data collection period, and willing to participate. Those who did not meet the eligibility criteria and submitted incomplete answers were excluded from the study. During the data collection period, the Balinese government relaxed its COVID-19 restrictions on community activities between districts and cities. A special task force was also established to address the spread of COVID-19 through traditional markets.

Bali is among the top 10 Indonesian provinces showing the highest number of COVID-19 cases, with ∼14,596 cases and 476 deaths recorded as of December 17, 2020 (14). In congruence with the central government campaign, Bali implemented new customs and adaptations on July 5, 2020 (15, 16). As it does not seem likely that local governments will directly limit personal activities, COVID-19 control measures will heavily depend on whether individual communities can adapt to these new habits, especially those which are part of the prevention protocol (16, 17). As such, the capacity to adapt to these public health measures is an essential factor for success, particularly while there is no widely available vaccine for containing or preventing COVID-19.

Study Variables

In this study, the dependent variable was set as "adherence to COVID-19 public health measures," which was determined based on the total score achieved after combining scores from individual indicators, including mask usage, hand washing, keeping distance, changing clothes, covering the nose when sneezing/coughing, and avoiding crowds. Each item was rated on a Likert scale ranging from 1 (never) to 4 (always).

The independent variables consisted of the following five main factors:

(i) Demographic characteristics (i.e., gender, age, marital status, number of children, education level, district of residence, and type of occupation). Education level was divided into primary education (did not attend formal school, through high school) and university (diplomas to graduate school). Marital status and number of children were combined to form the following categories: unmarried, married with no children, and married with children. Finally, type of occupation included civil servants, private employees/laborers, others (freelancers, self-employed, farmers, and traders), unemployed, and students.

(ii) Perception of the value of public health measures (i.e., value of health, economic, and social benefits). This variable was assessed based on the total scores achieved after combining scores from responses to the health-related benefits of mask usage, washing hands, and keeping distance. Each statement was rated according to a Likert scale ranging from 1 (strongly disagree) to 4 (strongly agree). An item was measured based on health, e.g., "The health protocol for wearing a mask during activities has benefited me in maintaining my health." Perception of the value of economic benefits was assessed based on the total scores achieved after combining scores from responses to the economic/job benefits of mask usage, washing hands, and keeping distance. Here, each item was also rated according to a Likert scale ranging from 1 (strongly disagree) to 4 (strongly agree). An item was measured based on the value of economic benefits, e.g., "The health protocol for wearing a mask helps my business and my job." Perception of the value of social benefits was measured based on responses to one item, which was scored according to the same Likert scale ranging from 1 (strongly disagree) to 4 (strongly agree). Perception of the value of social benefits was measured based on "The health protocols for wearing a mask, washing hands, and physical distancing have disturbed my social life."

(iii) Perception of the rules for COVID-19 control (i.e., social norms and formal rules). Social norms were assessed based on the total scores achieved after combining scores from six items related to community participation; that is, whether people in the community implemented public health measures. All items were measured according to a Likert scale ranging from 1 (never) to 4 (always). Item was measured based on social norms, e.g., "People in my area keep their distance and reduce physical contact." Formal rules were assessed based on the total scores achieved after combining scores from five items related to formal government regulations targeted at public health measures. All items were measured using a Likert scale ranging from 1 (never) to 4 (always). Item was measured based on formal rules, e.g., "The current regulations for COVID-19 require masks when performing activities outside and working."

(iv) Knowledge of COVID-19 and public health measures targeted at the new normal were assessed based on the total scores achieved after combining scores from 10 items that were answered and scored as follows: correct answer choice (1) and wrong/do not know (0) for positive questions, and wrong answer choice (1) and true/do not know (0) for negative questions. Item was measured for knowledge of COVID-19, e.g., "The main clinical symptoms of COVID-19 are fever, dry cough, sore throat, loss of smell, and breathing difficulties."

(v) Other factors related to health protocol adherence, including risk perception, fear perception, trust in the government, COVID-19 test history, respondent health status, and access to COVID-19 prevention instruments. Risk perception was measured based on one statement that was answered according to a Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Fear perception was measured based on the total scores achieved after combining scores for seven items, each of which were answered according to a Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree) (17). History of COVID-19 tests (either via swab PCR or rapid testing) was answered as either No or Yes. Trust in the government was assessed based on one statement, which was answered according a Likert scale ranging from 1 (disagree) to 4 (strongly agree). Individual health status was measured according to a Likert scale ranging from 1 (very bad) to 5 (very good), then divided for analysis purposes into categories of bad (very bad to sufficient), good, and very good. Access to COVID-19 prevention instruments was assessed based on four items related to individual access to masks and handwashing locations as well as whether participants were accustomed to washing their hands and using hand sanitizer; all factors were rated according to a Likert scale ranging from 1 (strongly agree) to 4 (strongly disagree).

Testing the validity and reliability of the instrument with related experts was carried out before the instrument was disseminated, and to strengthen this, the validity and reliability tests were carried out simultaneously following the research data collection. From a total sample of 743, the results of validity and reliability tests with the Pearson correlation statistical test (r count $> r$ table or ir-cor more than 0.3) and Cronbach alpha (>0.6) meaning that the instrument used is valid and reliable.

Statistical Analysis

All data were edited and cleaned for analysis. Descriptive statistics were used to obtain variable distributions (i.e., frequencies, percentages, means, and standard deviations). We applied a bivariate linear regression test to determine crude associations between independent and dependent variables; we nominated candidate variables with p-values < 0.25. A multiple linear regression analysis was performed to determine which independent variables were associated with the dependent variable. Results were considered significant based on p-values < 0.05. All data analyses were conducted using Stata 14.0.

Ethical Approval

This study received approval with Ethics Decree Number: 1303 /UN14.2.2.VII.14/LT/2020, dated June 23, 2020, from the Ethics Commission, Faculty of Medicine, Udayana University.

TABLE 1 | Sociodemographic characteristics of the study participants.

Variable	n (%)
Sex	
Male	274 (36.88)
Female	469 (63.12)
Age	
<20 years	63 (8.48)
21–30 years	433 (58.28)
31–40 years	161 (21.67)
>40 years	86 (11.57)
Marital status and number of children	
Single	383 (51.55)
Married without children	62 (8.34)
Married with children	298 (40.11)
Latest education	
Primary education	194 (26.11)
University	549 (73.89)
Districts	
Outside Denpasar	445 (59.89)
Denpasar	298 (40.11)
Type of occupation	
Student	120 (16.15)
Not working	87 (11.71)
Others (self-employed, farmer, trader)	142 (19.11)
Private employee/laborer	268 (36.07)
Civil servant	126 (16.96)

All respondents gave their consent to participate. The first 500 were rewarded with telephone credits or electronic money transfers amounting to Rp 25,000 (around USD $1.78), while eight participants were randomly selected to received amounts of Rp 250,000 (around USD $17.76).

RESULTS

We initially received a total of 954 individual survey responses, but only 743 (77.8%) of these were analyzed (i.e., participants met the eligibility criteria and submitted complete answers). **Table 1** shows their sociodemographic characteristics. As shown, most respondents were women (63%), relatively young (88% were <40 years of age), and unmarried (52%). Furthermore, a large majority (74%) were university graduates. Finally, most (36%) worked in the private sector.

Table 2 shows the distribution of indicators for COVID-19-related public health measures. As shown, average adherence was 32.59 (range of 20–36). Detailed information on the adherence levels per question item are available in **Supplementary File 2**. In summary, the highest scores were found for compliance with mask usage when going outdoors, while the lowest were found for doing so with the family when at home. The perceptions of health and economic value related to the application of public health measures produced averages of 10.82 and 10.62, respectively (total scores ranging from 5 to −12). The proportions of answers per item for the perceptions of health and economic

TABLE 2 | Distribution compliance to COVID-19 prevention measures and VRK constructs.

Variable	n (%)
Public health measures compliance (mean ± SD)	32.59 (3.08)
Perception of the value of health benefits (mean ± SD)	10.82 (1.36)
Perception of the value of economic benefits (mean ± SD)	10.62 (1.49)
Perception of social value (public health measures affect social life)	
Strongly agree	85 (11.44)
Agree	132 (17.77)
Disagree	428 (57.60)
Strongly disagree	98 (13.19)
Perception of social norms (mean ± SD)	19.09 (3.43)
Perception of formal rules (mean ± SD)	16.84 (2.59)
Knowledge (mean ± SD)	9.17 (1.61)
COVID-19 test history	
No	558 (75.10)
Yes	185 (24.90)
Health status	
Bad	41 (5.52)
Good	368 (49.53)
Very good	334 (44.95)
Perception of risk	
Strongly agree	106 (14.27)
Disagree	84 (11.31)
Neutral	190 (25.57)
Agree	281 (37.82)
Strongly disagree	82 (11.04)
Perception of fear (mean ± SD)	20.50 (5.31)
Access to masks and washing hands (mean ± SD)	13.16 (1.78)
Trust in the government	
Disagree	47 (6.33)
Neutral	122 (16.42)
Agree	324 (43.61)
Strongly agree	250 (33.65)

value are available in **Supplementary File 3**. Results also showed that a high proportion of respondents expressed disapproval due to health protocols that interfered with their social lives. For the perception of rules, the average social norm score was 19.09 out of a possible total score ranging from 6 to 24, while the average formal rule score was 16.84 out of a possible total score ranging from 5 to 20. The complete results for the perceptions of formal rules and social norms are available in **Supplementary File 4**. Other factors concerning knowledge related to COVID-19 obtained an average of 9.17 out of a possible total score ranging from 0 to 10. The complete results for the knowledge section are available in **Supplementary File 5**. Survey results also showed an average score for COVID-19 fear perception of 20.50 out of a total possible score ranging from 7 to 35. A similar trend was found for perceived risk, in which only about half of the respondents agreed or strongly agreed that there was a high risk of COVID-19 infection. Access to COVID-19 prevention instruments showed an average of 13.16 out of a total possible score ranging from 7 to 16. Detailed results for both these

variables are available in **Supplementary Files 6, 7**, respectively. Finally, a high proportion of respondents trusted the government to control the spread of COVID-19.

Table 3 shows the results of both the bivariate and multiple linear regression analyses. The bivariate analysis showed that several factors were statistically associated with adherence to public health measures, including being female, married with children, COVID-19 test histories, health status, risk perception, fear perception, access to masks and handwashing, trust, valuing public health measures, and perceived social norms and rules. However, the multiple linear regression analysis only showed that perceived social norms, perceived health benefits from public health measures, being female, and COVID-19 test histories were significantly associated with adherence to public health measures.

DISCUSSION

The COVID-19 pandemic has resulted in a variety of global changes that have impacted public health policies. Those designed to handle COVID-19 are typically conducted through health promotions targeted at the implementation of clean and healthy lifestyles, social and physical distancing, mandates to study and work at home, and mask usage during all community activities. This study found that the level of adherence to public health measures was directly proportional to social norms, meaning that individuals are more likely to adapt when those around them are also adaptive. In the COVID-19 era, social norms are more focused on the rules. Citizens are also expected to remind each other about the continual implementation of public health measures. The willingness and ability of community members to maintain behaviors that adhere to COVID-19 measures while advocating that others do so are crucial elements for widespread adoption (18). A social norm is what people in some groups believe to be normal in the group, that is, believed to be a typical action, an appropriate action, or both. It is believed that social norms may greatly influence health-related choice and behavior (19). In this context, the government must support formal rules and regulations while monitoring their implementation. Otherwise, unintentional consequences may arise, including, but not limited to, social interactional trouble between those who adopt and advocate public health measures and those who refuse to do so (18).

As described earlier, there are several health-related values and benefits to the practice of complying with public health measures (e.g., mask usage, washing hands with running water and soap, and keeping distances of 1–2 m). Mask usage can prevent the inhalation of large droplets and sprays but have limited ability to filter submicron-sized airborne particles of COVID-19 (20). Hand hygiene is essential for reducing COVID-19 transmission. Here are a variety of hand hygiene products available; however, their safety and efficacy vary (21). These elements increase personal safety while dramatically affecting adherence at the community level (22). Adaptation strategies can also be promoted through the consideration of existing social norms and increasing the overall perception of related benefits, particularly in terms of health. Policymakers and public health officers should be active in maximizing these benefits, which can

increase the general level of social adherence to public health protocol (23).

Notably, this study also found that female respondents reported higher levels of adherence to public health measures than male respondents. This is similar to previous findings showing that women used masks and washed their hands at 12% higher rates (95% CI = 1.03–1.22, $p < 0.05$) than men (22). Moreover, females also declared a higher daily frequency of handwashing and washing their hands always when necessary more often than males. Males more often indicated various reasons for not handwashing, including there is no need to do it, they do not feel like doing it, and they have no time to do it (24). Based on other research, this may be rooted in the suggestion that women are generally more willing to maintain their health when compared with men (25).

In Bali, COVID-19 testing can be accomplished through either a rapid antibody test or PCR swab. In this study, respondents with histories of either type of COVID-19 test were more compliant than those who had never been tested. In addition, participation might have been higher among persons who knew someone who had tested positive or had died from COVID-19, which could have affected support for and adherence to mitigation efforts (26). Experiences with the COVID-19 test may also be related to higher perceived risks and perceived seriousness of the virus; in turn, this influences the decision to adopt public health measures targeted at COVID-19 prevention (27). Due to the low per-capita coverage rates of COVID-19 testing in Bali (and Indonesia as a whole), improved testing rates may therefore facilitate the adoption of public health measures designed to prevent transmission (28).

LIMITATIONS

While this study produced valuable findings, there were also some limitations. Due to the nature of online surveys, respondent biases may have influenced the results. For example, low participation among the elderly most likely affected the overall analysis. Evidence suggests that older groups are at higher risk for severe COVID-19 infection; these individuals also have higher perception risks than individuals in younger age groups (29–32). Moreover, there is limited reach of the filled audience because it depends on the initial networks that the researchers deployed, so this cannot be stated as representative. Nevertheless, this research finding may inform and assist the provincial government on evidence-based strategies as it provides self-reported Balinese behaviors, knowledge, and adherence to health protocols. This further indicates the need for better public health measures designed to promote appropriate behaviors during the COVID-19 pandemic. Future studies should therefore consider more representative sampling methods, thus increasing generalizability.

CONCLUSIONS

In Bali Province, several factors influenced the level of adherence to public health measures targeted at COVID-19. More specifically, this included the perception of social norms, perception of health-related benefits and values, gender, and

TABLE 3 | Factors affecting adherence to public health measures.

Variable	Bivariate analysis				Multivariate analysis			
		95% CI		p_value		95% CI		p_value
	B	Lower	Upper		B	Lower	Upper	
Sex								
Male								
Female	0.96	0.51	1.42	0.000*	0.58	0.18	0.98	0.004*
Age								
<20 years								
21–30 years	0.46	−0.35	1.27	0.264				
31–40 years	0.29	−0.61	1.19	0.531				
>40 years	0.36	−0.64	1.36	0.482				
Marital status and number of children								
Single								
Married without children	0.22	−0.61	1.04	0.587	−0.10	−0.84	0.63	0.781
Married with children	0.67	0.20	1.13	0.005*	0.18	−0.29	0.64	0.460
Latest education								
Primary education								
University	0.28	−0.22	0.79	0.270				
Districts								
Outside Denpasar								
Denpasar	0.03	−0.43	0.47	0.916				
Type of occupation								
Student	−0.54	−1.31	0.23	0.171	−0.32	−1.11	0.45	0.416
Not working	−0.72	−1.55	0.12	0.092	−0.24	−1.03	0.53	0.539
Others (self-employed, farmer, trader)	0.14	−0.59	0.88	0.704	0.23	−0.44	0.89	0.510
Private employee/laborer	0.31	−0.34	0.96	0.344	0.36	−0.23	0.95	0.236
Civil servant								
COVID-19 test history								
No								
Yes	1.02	0.51	1.52	0.000*	0.89	0.45	1.34	0.000*
Health status								
Bad								
Good	1.07	0.09	2.06	0.032*	0.59	−0.28	1.45	0.183
Very good	1.77	0.78	2.76	0.000*	0.81	−0.08	1.70	0.074
Perception of risk								
Strongly disagree								
Disagree	−0.82	−1.70	0.05	0.065	−0.07	−0.85	0.72	0.866
Neutral	−1.12	−1.84	−0.39	0.003*	−0.43	−1.18	0.23	0.197
Agree	−1.28	−1.96	−0.59	0.000*	−0.59	−1.36	0.07	0.078
Strongly disagree	−1.15	−2.03	−0.26	0.011*	−0.81	−1.66	0.02	0.056
Perception of fear	0.05	0.01	0.09	0.017*	0.03	−0.01	0.07	0.147
Access to masks and washing hands	0.39	0.27	0.51	0.000*	0.08	−0.04	0.22	0.184
Perception of the value of health benefits	0.58	0.43	0.74	0.000*	0.35	0.20	0.49	0.001*
Perception of the value of economic benefits	0.49	0.35	0.64	0.000*	0.06	−0.16	0.28	0.601
Perception of the value of social benefits								
Strongly agree								
Agree	−1.87	−2.70	−1.04	0.000*	−0.66	−1.44	0.13	0.099
Disagree	−0.77	−1.58	−0.17	0.015*	−0.18	−0.84	0.48	0.600
Strongly disagree	0.09	−0.97	0.79	0.841	−0.18	−0.96	0.62	0.661
Perception of social norms	0.41	0.35	0.46	0.000*	0.37	0.32	0.43	0.000*
Perception of formal rules	0.36	0.27	0.44	0.000*	0.03	−0.06	0.13	0.487
Knowledge	0.12	0.02	0.25	0.100	−0.02	−0.15	0.12	0.815
Trust in the government								
Disagree								
Neutral	−0.23	−1.25	0.79	0.656	−0.21	−1.13	0.71	0.657
Agree	0.78	−0.15	1.71	0.099	−0.07	−0.92	0.79	0.881
Strongly agree	1.38	0.43	2.32	0.004*	−0.50	−1.41	0.42	0.284

*p ≤ 0.05.

COVID-19 test histories. In the context of COVID-19, such adherence is strongly impacted by the social roles played by individuals within the community, who must make appropriate adaptations to prevent viral transmission. As additional policies should be enacted to reinforce the current level of adaptation, continued research is needed to explore social norms and interactions in the context of the pandemic era. Findings will be crucial, since it is very unlikely that the COVID-19 pandemic constitutes the final global health threat.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Ethics Commission, Faculty of Medicine, Udayana University. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpubh.2021.646764/full#supplementary-material

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Handwashing Message Type Predicts Behavioral Intentions in the United States at the Beginning of the Global COVID-19 Pandemic

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Handwashing has been widely recommended to reduce the spread of COVID-19. Despite this, handwashing behavior remains low in the general public. Social marketing has been employed as a successful health promotion strategy for changing many health behaviors in the past. The present study examines if message framing influences the effectiveness of a handwashing health promotion messages at the early stages of the COVID-19 pandemic. In a between-subjects cross-sectional experiment, participants ($N = 344$) in the United States were randomly assigned to view one of four handwashing messages or a control message before completing self-report measures of attitudes, emotions, readiness to change, and behavioral intentions around handwashing. Simple handwashing messages were presented with different framings, including a simple exchange message, a gain message, a social norm appeal, and a guilt appeal. Results revealed that message type influenced handwashing behavioral intentions and emotions. *Post-hoc* comparisons revealed that the simple exchange message produced significantly higher intentions than other messages and that only the simple exchange message significantly differed from the control message on emotions regarding handwashing. Mediational analyses showed handwashing emotions fully mediated the relationship between messaging and handwashing intentions. This mediation effect was moderated by age, such that it occurred for the younger and middle age participants, but not older participants. These results suggest that even simple, brief, and easily conveyable messages can positively impact behavioral intentions around handwashing during the early stages of a health crisis. Consistent with recent research comparing affective and cognitive pathways for health behavior, the mediational analysis suggests that effect of the simple exchange message on intentions was due to increased positive emotions around handwashing.

Keywords: COVID-19, social marketing, handwashing, emotion, exchange theory, intentions

INTRODUCTION

The Novel Coronavirus 2019 (COVID-19) has undeniably affected life in the United States and around the world. The United States has suffered from increased unemployment, disruptions to educational and leisure activities, and economic struggles. The United States has disproportionately high rates of morbidity and mortality due to COVID-19; despite having only 4% of the world's population, as of July 2020 the United States is responsible for 25% of the world's COVID-19 cases (1). This prevalence of COVID-19 and the concerted efforts to educate the public on its prevention has affected public awareness of preventive health behaviors, including handwashing (2).

Handwashing is a frequently recommended way of preventing disease and reducing the spread of illness and has been touted as a way to prevent spreading COVID-19. The Centers for Disease Control and Prevention (3) recommends individuals wash their hands for at least 20 s, ensuring all skin on the hands is washed. The CDC guidelines also include recommendations for washing hands after visiting the bathroom, before and after eating, and after touching one's face (3, 4). Proper handwashing has long been shown to reduce bacterial load on hands and to reduce the risks of contracting gastrointestinal and respiratory illnesses (5–7). Additionally, and vital to the context of COVID-19, handwashing has previously been associated with a reduced risk of contracting influenza (8). While data related to handwashing and COVID-19 is still emerging, at least one 2020 study shows a correlation between *interest* in handwashing, as measured by Google searches, and reduced COVID-19 spread (9).

Despite the numerous protective benefits associated with handwashing, many still do not perform proper handwashing behaviors. Prior to COVID-19, only two-thirds of people self-reported washing their hands after using public restrooms or after coughing or sneezing, and approximately one third of people wash their hands after shaking hands (10). Healthcare settings are vulnerable to low handwashing compliance as well. The CDC estimates that healthcare workers wash their hands <50% of the time in daily situations where handwashing is recommended (3).

These data suggest that more work must be done to change handwashing behaviors in the United States. However, widespread health behavior change is challenging to achieve. Due to the difficulty inherent in changing behaviors, health promotion interventions often utilize *social marketing* to encourage behavior change. The social marketing approach uses traditional marketing strategies of exchange—where an individual pays some cost to receive some benefit— to promote behavior change (11). *Exchange theory* sits at the heart of social marketing. As in traditional marketing, exchange theory explains that for a behavior to occur, the intended audience must find the desired behavior to be equal to, or greater in value than, the cost to perform the behavior (12). This exchange applies to social marketing as well; the intended population must find the benefits to themselves (or to society) are worth the cost of performing a given behavior (12). To achieve successful exchange, social marketing researchers have developed a variety of approaches for framing health message. Social marketing utilizing exchange theory has been a tool in health promotion and has been

successful in improving health behaviors and its use has increased self-reported handwashing in the past (13–15).

In this study four specific message types were compared to a no-message control: gain framing, social norm, guilt appeal, and simple exchange. First, *gain framing* is a well-known approach to health promotion campaigns. Gain frames highlight how an individual will benefit, or what they will gain from performing a behavior, as opposed to what negatives they will avoid (16, 17). *Social norms approaches* share behavioral information about a given population in an effort to encourage behavior change. For example, social norms have strong influences on behaviors like cannabis use and healthy eating (18, 19). There is evidence of the efficacy of social norms messaging for encouraging positive health behaviors (20), and thus may present a powerful type of message for increasing handwashing (21). *Guilt appeals* are messages that highlight the inherent desire to fix previously immoral, inappropriate, or unhealthy behaviors (22). Antonetti et al. (23) explain that guilt appeals can successfully help change relational or social behaviors. Finally, simple *exchange messages* make clear both the cost of the behavior, and the benefit.

Although frequently effective, social marketing is not a one-size fits all tool. Differences in barriers, awareness, skills, and social and built environments can affect how individuals receive various social marketing messages, and their readiness for behavior change. For this reason, successful marketing is achieved by aligning social marketing messages with the target population in a given context (12). The primary goal of the present research is to compare the effectiveness of four different social marketing message frames for improving responsiveness to a handwashing message in the United States as the beginning of the COVD-19 pandemic.

While social marketing messaging is known to impact behavior change, the mechanism for why this occurs is also still unclear. Many health behavior theories consider behavior change to occur due to cognitive mechanisms, such as attitudes [e.g., (24, 25)]. Recent research suggests that affective or emotional responses may also be important independent mechanisms of change in intentions and behavior [for a review, see (26)]. The present study hypothesizes that the cognitive variable of attitudes and the affective variable of emotions will be unique and independent mediators of the relationship between message framing and behavioral intentions and readiness to change.

The present study also utilizes the Transtheoretical Model (TTM) to examine handwashing behavioral intention. The TTM is a model that describes behavior as traveling through a series of stages—precontemplation, contemplation, preparation, action, maintenance, and termination (27–29). While originally developed after examining the behaviors of smokers who had successfully stopped smoking (27), the transtheoretical model had since been applied to numerous other areas of health behavior change (30). Understanding the stage in which an individual resides is important when creating behavior change messages; thus, the present study explores if readiness to change varied based on different message types.

Finally, due to extensive media coverage of age differences in the effects of COVID-19 age was considered as a possible moderating variable. Discussions around the greater danger of

COVID-19 to older Americans may have resulted in the false belief that younger people do not need to increase behaviors like handwashing to the same extent of older people. Previous studies on beliefs about preventative pandemic behaviors demonstrate this; college-aged participants believed that children and the elderly were most vulnerable to disease, and that teens and young adults were less at risk for contracting a pandemic influenza (31). In the current pandemic, there is evidence of younger Americans disregarding health recommendations in order to attend social events (32–34), resulting in new outbreaks of COVID-19 cases. Given this, it is important to learn the impact of age on intentions to take preventative actions, like handwashing.

The present study compares four different social marketing messages for increasing handwashing attitudes, readiness to change, emotions, and behavioral intentions in order to better understand the most effective way to facilitate adherence to handwashing guidelines during the COVID-19 pandemic. Based on these social marketing principles, new messages were created for this study. Further, the study explores whether attitudes or emotions may serve as mediators of the effect of the messages on behavioral intentions and readiness to change. The study also examines the possibility that age moderates the effectiveness of the handwashing messages. Some variables included in this study, such as the demographic items, handwashing attitudes, emotions, intentions, and readiness to change, have been presented in a paper by Clemens et al. (35). The present experimental study focuses on a handwashing message manipulation and its effect on handwashing-related variables such as intentions. While there is overlap in data, separate, a priori hypotheses and analyses were used in each paper.

METHODS AND MATERIALS

The present between-subjects cross-sectional design experiment utilized Qualtrics to randomly display a simple message manipulation in order to determine the effect of message type on measures capturing handwashing related attitudes, readiness to change, emotions, and behavioral intentions. All methods and measures were approved by the University of (name redacted for blind review) Social, Behavioral, and Educational institutional review board (IRB protocol number: 300597) and were conducted in compliance with the guidelines of the American Psychological Association.

Participants

Participants ($N = 344$) were recruited via Prolific (an online participant recruitment system) until available budget was exhausted. All participants received monetary compensation for their time. Of these participants, 54.1% identified as women, 43.9% identified as men, and 1.5% identified as another gender or preferred not to disclose their gender. Participants ranged in age from 18 to 74 ($M = 32.69$, $SD = 11.60$). Participants represented 44 of the 50 United States and were 68% White, 16% Asian/Asian-American, 5% Black, 5% Latinx, and 6% two or more races. For participant income level, 23.7% reported household income lower than $30,000, 37.5% reported between $30,000 and 69.999, 18.9% reported between $70,000 and 99,999, and 19.9% reported

income of $100,000 or more. Participants were recruited via Prolific to represent, as closely as possible, the general population of the United States.

Measures and Materials
Demographics
A demographic questionnaire included questions regarding age, race and ethnicity, geographic location, and income level of participants. This questionnaire was also used to capture information about COVID-19 in the participant's community, however these data were not included in the present analyses. Demographic items were shown at the end of the study to avoid the potential of influence on primary dependent measures. See **Supplementary Materials** for copies of the measures.

Handwashing Messages
Participants were randomly assigned to view one of five messages at the beginning of the study. Messages included either one of four handwashing message approaches described earlier: gain framing, social norm, guilt appeal, and exchange or a fifth control message. All five messages were shown with identical graphics. The control message ($n = 73$) simply read, "Press the arrow to continue." The different messages can be viewed in **Figure 1**. The four handwashing messages utilized different framings often used in exchange theory social marketing: a gain frame ($n = 66$), a social norms approach ($n = 68$), a simple exchange message ($n = 65$), and a guilt appeal ($n = 70$).

Handwashing Attitudes
Participants' attitudes toward handwashing were evaluated using a two-item measure. Items such as "handwashing is important" were scored on a seven-point Likert scale ranging from (1) *strongly agree* to (7) *strongly disagree.* Items asked participants to rate the importance and effectiveness of handwashing in preventing COVID-19. Items used in this measure demonstrated acceptable internal consistency with a Spearman-Brown reliability coefficient of 0.78.

Handwashing Emotions
Handwashing emotions were measured using five items assessing discrete emotions related to handwashing. Scale items included emotions of both positive and negative valences, such as "I am proud of washing my hands" and "I would feel guilty if I did not wash my hands." Items were scored using a seven-point Likert scale ranging from (1) *strongly disagree* to (7) *strongly agree.* This scale demonstrated strong internal consistency ($\alpha = 0.83$).

Handwashing Intentions
Handwashing intentions were measured using six items targeting intention to wash one's hands in scenarios recommended by the CDC and according to the guidelines they provided, such as "after blowing your nose, coughing or sneezing" and "for at least 20 seconds each time." Items were reported on a five-point Likert scale ranging from (1) *never* to (5) *always*. The scale demonstrated high internal consistency ($\alpha = 0.80$).

FIGURE 1 | Handwashing messages shown to participants. The top left shows the simple exchange message, the top right message shows the gain message, the bottom left message shows the norm message, and the bottom right message shows the guilt message. Similar images were used.

Handwashing Readiness to Change

Participants' stage of change was determined using a single item modeled on the work of (36). Participants were asked to select the option which best reflected their intention to wash their hands according to CDC guidelines (e.g., for 20 s multiple times daily). Response options included "I do not intend to do this," "I have thought about doing this, but do not yet plan to," "I intend to do this, but have not done it yet," "I am actively doing this," and "This is something that I have done for a long time, and intend to continue doing to prevent disease."

Data Analysis

Statistical analyses conducted included correlations between all focal variables and standard one-way ANOVA tests to examine the influence of each message on the variables of handwashing intention, emotions, attitudes, and readiness to change. Welch ANOVA and Games-Howell *post-hoc* tests were conducted when tests violated the assumption of homogeneity of variance. The PROCESS macro for SPSS (37) was used to test for mediation by emotions and attitudes and for the possible moderation by participant age. Data has been made available on the Open Science Framework.

RESULTS

Means, standard deviations, and correlations between the variables are shown in **Table 1**. Handwashing intentions, readiness for change, attitudes, and emotions were all positively correlated. Further, handwashing intentions and readiness to change increased with participant age.

Preliminary analyses showed that standard ANOVA tests violated the assumption of homogeneity of variance. As such,

TABLE 1 | Means, standard deviations, and correlations between measures.

	M	*SD*	**1.**	**2.**	**3.**	**4.**
Handwashing intentions	4.45	0.59	–			
Handwashing emotions	5.47	1.07	0.48***	–		
Handwashing attitudes	6.67	0.50	0.41**	0.39***	–	
Handwashing readiness to change	4.25	0.77	0.47***	0.33***	0.22***	–
Age	32.69	11.60	0.18**	0.08	0.10	0.11*

*p < 0.05, **p < 0.01, ***p < 0.001.

Welch ANOVA, which does not assume equal variance, was employed. Significant omnibus tests were followed up with Games–Howell *post-hoc* comparisons for unequal variances. A series of one-way ANOVAs revealed that message type influenced handwashing behavioral intentions, Welch's $F_{(4, 166.59)} = 4.38$, $p = 0.002$, and emotions, Welch's $F_{(4, 168.13)} = 3.11$, $p = 0.017$, but had no statistical impact on handwashing attitudes or readiness to change. As displayed in **Table 2**, *post-hoc* comparisons revealed that the social exchange message produced significantly higher intentions than the control message, gain message, or guilt appeal, and was the only message type to change intention compared to the control message. Similarly, *post-hoc* comparisons revealed that only the exchange message significantly differed from the control message on emotions regarding handwashing (e.g., "I am proud of washing my hands").

Mediational Analyses

Mediational analyses (37) were then conducted to determine if the exchange message predicted intentions as a result of

TABLE 2 | Means and standard deviations on intentions and emotion measures and significant condition differences on these measures from the simple exchange message condition.

Construct	Message	M	SD	p
Handwashing intentions	Simple exchange message	4.66	0.39	–
	Norm appeal	4.46	0.53	0.083
	Gain message	4.38	0.65	0.028*
	Guilt message	4.38	0.63	0.019*
	Control message	4.40	0.68	0.048*
Handwashing emotions	Simple exchange message	5.81	0.83	–
	Norm appeal	5.36	1.08	0.060
	Gain message	5.51	1.08	0.376
	Guilt message	5.44	1.06	0.170
	Control message	5.28	1.20	0.026*

*p-values indicate differences from the simple exchange message. *p < 0.05.*

FIGURE 2 | The mediational model.
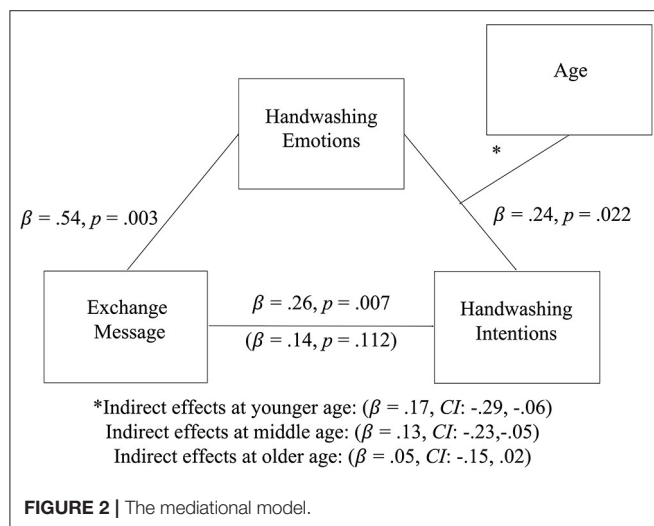
handwashing attitudes and emotions. Handwashing emotions (and not handwashing attitudes) completely mediated the relationship between messaging (coded as those who received the simple exchange message and those who received a control message) and handwashing intentions (see **Figure 2**).

Critically, this mediation effect was moderated by age, such that it occurred for the younger [95% CI (−0.29 to −0.06)], and middle age participants [95% CI (−0.23 to −0.05)], but not older participants [95% CI (−0.15 to 0.02)]. That is, the conditional process analysis, indicated that the exchange message escalated feelings about handwashing which, in turn, increased handwashing intentions for younger and middle-aged adults. This model resulted in a significant index of moderated-mediation, 95% CI (0.01 to 0.13) (38). Exploratory analyses with other demographic variables are presented in the **Supplementary Materials**.

DISCUSSION

This study demonstrates that the type of exchange theory-based social marketing message influences handwashing emotions and behavioral intentions, but does not significantly impact handwashing attitudes or readiness to change. Participants who were shown a simple exchange message, a message where a clear benefit and avoided consequence were given, were found to have more positive handwashing emotions and to have higher intentions to wash their hands than those shown other messages or a control message.

This study also suggests different message types housed under the exchange theory can produce different results. The first objective of this study was to compare the ability of four different approaches (vs. a control condition) of presenting a simple handwashing message to change intentions and readiness to change. This aligns with findings from previous handwashing message studies, such as that by (39), which find differential effects of brief handwashing message types, and adds evidence for this in the context of a global health emergency. Simple exchange message were found to be the most effective in increasing handwashing emotions and behavioral intentions. The other three messages compared did not significantly differ from one another on any of the dependent measures. While it is unclear why these messages were the most effective, it may be that the media's focus on the dangers of COVID-19 resulted in the simple exchange message seeming most valuable. The simple exchange message highlights the extra time spent washing hands (the cost) to avoid illness (the benefit). This highlights the avoidance of illness as the benefit, as opposed to maintaining health, being like others, or protecting loved ones, and may connect individuals more to the actual danger presented by COVID-19, thus increasing handwashing related intentions and emotions.

There are other possible reasons why the simple exchange message was found most influential. It is possible the spread of COVID-19 and the subsequent stay-at-home orders in the US created a natural experiment in which the exchange message was most effective. People were overwhelmingly at home, and the inconvenience and time spent washing hands may have been less of a barrier. Further, the social norms message might have resonated less because people were more separated from their social groups. The guilt appeal may have not been as effective because negative emotional appeals like guilt appeals can often have the opposite effect. Individuals instead ignore the message if it comes across as too powerful or too weak (23, 40). Negative emotional appeals like the guilt appeal may still work, but they may require additional work to find the middle ground that is appealing to audiences. This line of research would benefit from future studies exploring both why, when, and for whom these differences occur. Future studies could also more directly examine when a guilt appeal may be effective. Subsequent studies could also benefit from manipulation checks on the messages and the inclusion of pre-message measures, as this survey was kept intentionally as brief as possible. However, value was added using measures of mediators.

Mechanisms for Change in Behavioral Intentions

The second objective of this study involved considering handwashing attitudes and emotions as statistical mediators of the relationship between message reception and handwashing intentions. Thus, the mechanisms by which messaging impacted behavioral intentions were explored. Handwashing emotions, but not attitudes, were found to be a significant mediator of the relationship. This finding is consistent with research comparing affective and cognitive pathways for health behavior, in that the mediation analysis suggests that effect of the exchange message on intentions was due to increased positive emotions around handwashing [26]. The mediation by emotions, and not attitudes, highlights that emotions are strong motivators for behavior during health crises such as the current pandemic.

Lastly, as one of the objectives for this study, age was included in the mediational model as a possible moderator. Results suggest that while the exchange message increased handwashing emotions, which then increased handwashing intentions, this only occurred for younger and middle-aged participants. Older adults were not significantly influenced by this message to emotions pathway, perhaps because older participants already reported higher intentions to wash their hands. This finding suggests that social exchange messages for increasing handwashing will be most effective for individuals, such as younger and middle age individuals, with lower initial intentions to wash their hands regularly.

Theoretical, Social, and Policy Implications

The present study may provide insights about handwashing intentions that could be used in various settings in the future; such insights could inform handwashing messages to address the seasonal flu, influence message types in businesses or restaurants. Future studies could also help inform best-practice approaches for large-scale handwashing interventions in the event of another pandemic. The results of the present study also suggest that a theory-based, social marketing approach could be utilized for a successful health messaging campaign.

Limitations

The authors must acknowledge potential limitations as well as the strengths described above. Participants were recruited through a third-party recruitment service and were not specifically selected to match the demographic breakdown of the population of the United States. As such, the generalizability to different racial/ethnic populations is reduced. Future studies should examine the effectiveness of these social marketing frames in diverse samples. Additionally, given the atmosphere surrounding COVID-19 in the United States when the questionnaire was administered, participants may have been more receptive to the messages because of saturation of handwashing messaging in all media. The study also utilized self-report measures of behavioral intentions and did not determine how message type translates into actual handwashing behavior. The authors acknowledge limitations exist due to the few constructs used to measure important outcomes; the instrument only contains two items for attitudes, and one item for the stages of change. Due to the rapidity needed to create the questionnaire at the beginning of the pandemic, the authors also acknowledge it was not pre-tested. The present study may be influenced by the specific recruitment procedures involved in data collection, such as use of an online survey instrument, incentives, and self-reported measures. However, this approach was beneficial for obtaining timely data from a national sample on this critical issue during a pandemic, when face-to-face research was restricted. The authors also acknowledge that the messages shown to participants in the online questionnaire are only a few possible framings. It is unknown how different framings might compare to the messages shown in this study. Further exploration is warranted to understand how message framing like loss framing and fear appeals may be viewed by individuals during a pandemic. Additional studies may also benefit from increased sample sizes to improve generalizability.

CONCLUSIONS

These findings have implications for health messaging during public health emergencies. These results suggest that even simple, brief, and easily conveyable messages are able to positively impact behavioral intentions around handwashing during the early stages of a health crisis. Simple exchange messages may be particularly useful in increasing handwashing intentions for individuals with previously low intentions because of their ability to increase emotions toward the behavior. This also suggests that these types of messages may be successful in delivering social marketing messages about handwashing when there is already high awareness in the United States, as they do not rely on changing attitudes or other cognitive variables. Further, based on the mediational analyses, it appears that health messages designed to increase handwashing would benefit by directly targeting emotions.

This study has several strengths that make it an important addition to the scientific community. The authors are unaware of any scientific literature that specifically examine social marketing frames and handwashing messages in the context of COVID-19. This is also the only study the authors are aware of that examines handwashing messages using the Transtheoretical Model during the context of a pandemic. Finally, these data also add to the literature by showing that emotions, but not attitudes, statistically mediate the effect of social exchange messages on handwashing intentions.

DATA AVAILABILITY STATEMENT

The datasets presented in this study can be found in online repositories. The names of the repository/repositories and accession number(s) can be found below: https://osf.io/835p7/?view_only=6370596c6787415db68e27a4e81816ab.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by University of Toledo Institutional Review Board.

The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

JM was involved in the original design concept of the study, development of handwashing messages, data cleaning, and questionnaire design. KC was involved in the original design and formal data analysis of the study, and developed tables for the manuscript. KF was involved in the original design concept, questionnaire design, and supervision of the study. AG was involved in original design, study supervision, and data analysis. All authors participated in full review and editing of the final manuscript.

SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpubh.2021.583491/full#supplementary-material

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Prevalence of Depression, Anxiety, and Stress Among Repatriated Indonesian Migrant Workers During the COVID-19 Pandemic

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Introduction: Repatriated Indonesian migrant workers are vulnerable to developing serious mental health problems during the COVID-19 pandemic. This study aimed to assess the prevalence and associated factors of depression, anxiety, and stress among these populations during the COVID-19 pandemic.

Methods: Guided by the health belief model, a cross-sectional study design was employed among 335 participants, and primary data were collected through an online survey. Measured using DASS-21, anxiety, depression, and stress were the dependent variables. We performed descriptive and inferential statistical analyses—logistic regression was used to predict independently associated variables. STATA was used to execute all data analyses.

Results: The prevalence of depression, anxiety, and stress among repatriated Indonesian migrant workers were 10.15, 9.25, and 2.39%, respectively. The risk of anxiety and depression was low among those aged 21–30 years old, who had completed a university degree, were married, and had quarantined for 14 days. Conversely, the risk of anxiety and depression was high among those who had bad perceived health status, high perceived susceptibility, and negative stigma perception.

Conclusion: The prevalence of depression, anxiety, and stress among repatriated Indonesian migrant workers was relatively low compared to the general population. The risk of anxiety and depression was low among young people, educated people, and those under effective quarantine, but the risk was high among those who had negative perceptions about their health, stigma, and susceptibility to the disease.

Keywords: COVID-19, mental health, migrant worker, Indonesia, prevalence

INTRODUCTION

The 2019 coronavirus disease (COVID-19) was first identified as unexplained cases of pneumonia in Wuhan, China. Globally, there were about 53 million confirmed cases and 1.3 million deaths attributed to COVID-19 on 13 November 2020 (1). COVID-19 has affected both social and economic situations due to public health measures (2). Moreover, the mental health problem is another substantial negative impact caused by the multifaceted impacts of the pandemic (3, 4).

It is well-known that migrant workers have negative health outcomes involving mainly mental health and physical morbidities, and workplace accidents and injuries (5). A large number of women migrant workers have reported being sexually assaulted while they worked overseas and then return to their home countries deeply traumatized (6, 7). Furthermore, the mental health problem among migrant workers occurrs due to a series of socio-environmental variables, such as loss of social status, discrimination, and separation from the family (8).

Migrant workers were more vulnerable to suffering from mental health problems due to various concerns during the COVID-19 pandemic (9). The mental health situation of migrant workers is worsening during the COVID-19 pandemic, as they already have a lower quality of life compared to the local population (5, 10). Migrant workers also encounter more barriers in accessing health services in the host country due to government-recommended self-quarantine, inadequate health insurance, and a lack of information available in their own language (5, 11). This situation makes addressing the mental health of migrant workers during the COVID-19 pandemic complex, and is therefore a subject that has been neglected (12).

Indonesia is a country with many of its citizens working overseas as migrant workers. The repatriation of Indonesian migrant workers from the worst affected countries brings a challenge for COVID-19 prevention and control to Indonesia. About 34,300 migrant workers arrived in Indonesia by June 2020 (13). At the beginning of the COVID-19 pandemic in Indonesia, most of the COVID-19 cases were imported cases, particularly from migrant workers. There were 587 confirmed cases and 10 deaths among migrant workers in Indonesia (14). A similar situation occured in Bali Province. During the early period of the COVID-19 epidemic in Bali, transmission was predominantly from imported cases including from repatriated migrant workers (15). This situation was challenging both for migrant workers and the local government.

The COVID-19 situation will create a social transformation for migrant workers, particularly in Bali. Before the pandemic, migrant workers had a high social position. Sometimes, migrant workers were considered rich, with high-class jobs and dignity (16). After COVID-19, there was a negative stigma due to increasing COVID-19 cases among those groups. As the migrant workers sometimes experience rejection from their community, the government of Bali Province urged the public to stop stigmatizing migrant workers as "COVID-19 carriers" (17, 18). This phenomenon affected the mental well-being of the migrant workers who returned to Bali. Moreover, the uncertainty about the economic situation in Bali could worsen mental health among migrant workers. In response to this, this study sought to assess the prevalence of anxiety and depression among repatriated migrant workers in Bali during the COVID-19 pandemic. The study also aimed to identify the factors associated with anxiety and depression. The result of this study might be important for the government to formulate the best approach regarding the prevention of mental health problems, particularly among migrant workers.

METHODS

Study Design and Setting

We conducted an online cross-sectional study between 4 and 30 June 2020 using KoBo Toolbox, a free piece of software for online and offline data collection developed by Harvard Humanitarian Initiative. Indonesian migrant workers that arrived back to Bali during the COVID-19 pandemic were the targeted population. Adults aged 18 and above, and who can read and understand Bahasa Indonesian, were considered eligible, and we recruited the participants using a simplified-snowball sampling technique. We invited the participants through social media platforms (Facebook, WhatsApp, Instagram, and Twitter) because more than 60% of the Indonesian population use those platforms, including a group of migrant workers (19).

The sample was calculated using OpenEpi Version 3 (https://www.openepi.com) assuming the following parameters: the proportion of migrants with mental health problems as 30% (20), with 5% margin of error and 95% confidence interval. Finally, the minimum sample was 304.

Study Variables, Tools, and Measurement

The dependent variables were depression, anxiety, and stress, and were measured using the depression anxiety stress scale-21 (DASS-21) (21). The DASS-21 provides a short and concise measure for a mental health problem, which has already been validated using the Indonesian language (22). It consisted of 21 items: seven items for anxiety (item no 2, 4, 7, 9, 15, 19, and 20), seven items for depression (item no 3, 5, 10, 13, 16, 17, and 21), and seven items for stress (item no 1, 6, 8, 11, 12, 14, and 18). Each item was measured on a 4 point Likert scale ranging from 0 "never" to 3 "always." The level of depression, anxiety, and stress was calculated by multiplying the total score of each construct (consisted of seven items) by two, then re-categorized into five levels (normal to extremely severe).

The independent variables consisted of sociodemographic characteristics and constructs of the health belief model (HBM). Sociodemographic characteristics included gender, age, educational attainment, marital status, and working experience. Gender consisted of male and female; age was grouped into four categories (<20, 21–30, 31–40, and >41 years old). Educational attainment was grouped into high school graduated and university graduated; marital status consisted of single and married, and working experience was grouped into three categories (<1, 1–5, and >5 years).

The HBM constructs used in this study consisted of perceived susceptibility, perceived severity, self-efficacy, and cues to action. Items were adapted from previous studies (23–25). Each item

ranges from 1 "strongly disagree" and 5 "strongly agree" and is then summed up. The total score for each construct was then rated into two categories (low and high) based on the cut-off point using mean or median according to data distribution. Items about social support, social trust, perceived stigma, and experience on the COVID-19 test and quarantine were also adopted from previous studies (26–28).

Statistical Analysis

Data were described using descriptive statistics using proportions, mean, and percentages. This study employed a binary logistic regression model to identify the factors associated with anxiety and depression. First, bivariate logistic regression analysis was employed to find the crude associations between independent variables and dependent variables. In the second step, all variables with $p \leq 0.25$ in the bivariate analysis were included in the multiple logistic regression. Variables with $p \leq 0.05$ in the multiple logistic regression were considered as independent predictors for anxiety and depression. We described the strength of the measure of association using crude odds ratio (COR) in bivariate logistic regression analysis and adjusted odds ratio (aOR) in multiple logistic regression analysis. All data analyses were performed using STATA version 12.

Ethical Approval

This study protocol was approved by the Research Ethics Commission, Faculty of Medicine, Udayana University/Sanglah General Public Hospital, Bali Province, Indonesia (No 1147/UN14.2.2.VII.14/LT/2020). Participation in this study was voluntary and anonymous. Digital informed consent was obtained before the participant completed the online form. Each participant received IDR 25,000 phone credit if they completed the questionnaires.

FINDINGS

Demographic Characteristics, COVID-19 Related Experiences, and HBM Constructs

We received 347 responses during the survey period and 12 of them were excluded due to multiple responses. **Table 1** presents respondents' characteristics; most of the respondents involved were male and aged 21–30 years old. More than half of the respondents had graduated from a university and were married. Most of the respondents had worked as migrant workers for more than 5 years and more than half of them had not received compensation from their company or employer when they arrived back to Indonesia due to the COVID-19 pandemic. Overall, only 2.09% of the survey participants had ever been diagnosed with COVID-19. Furthermore, most of the respondents experienced rapid-test only and only 26.57% of them experienced both rapid-test and swab-test. After they arrived in Indonesia, most of the respondents underwent a 14-day quarantine, which consisted of self-quarantine and centralized quarantine provided by the government.

Meanwhile, from **Table 2**, we found most of the respondents believed that their health status was good. Moreover, more than half of them had low perceived severity, low perceived

susceptibility, low self-efficacy, and low cues to action. On the other hand, more than half of the respondents answered low in terms of both social support and social trust. Surprisingly, more than half of them stated they experienced rejection and perceived a negative stigma.

Prevalence of Depression, Anxiety, and Stress Among Indonesian Migrant Workers

This study found that 10.15% (95% CI = 6.8–13.4) of respondents had experienced depression, and 9.25% (95% CI = 6.1–12.4) of the respondents had experienced anxiety. Furthermore, only 2.39% (95% CI = 0.7–4.0) of the respondents were reported to experience stress. As the prevalence of stress was very low compared to the prevalence of depression and anxiety, we excluded the stress variable for the logistic regression analysis.

Factors Predicting Anxiety Among Indonesian Migrant Workers

Table 3 presents the unadjusted and adjusted odds ratio of factors linked with anxiety during COVID-19. An adjusted analysis found that being 21–30 years old, a university graduate, married, and undergoing 14-day quarantine was associated with lower anxiety. Those aged 21–30 years old were less likely to get anxiety by 73% (aOR = 0.27, 95%CI: 0.03–0.91; $p = 0.039$) compared to those aged less than 20. Similarly, university graduates were 70% less likely to get anxiety (aOR = 0.3, 95%CI: 0.1–0.89; $p = 0.030$) compared to high school graduates, and married participants were also less likely to get anxiety by 86% (aOR = 0.14, 95%CI: 0.03–0.58; $p = 0.007$) compared to single participants. Those who underwent 14-day quarantine were also 84%less likely to get anxiety by (aOR = 0.16, 95%CI: 0.03–0.98; $p = 0.047$) compared to their counterparts.

On the other hand, having a bad perceived health status, high perceived susceptibility, and perceived negative stigma were associated with higher anxiety. Those who felt bad about their health status were about three times more likely to get anxiety (aOR = 2.85; 95% CI = 1.02–7.99; $p = 0.046$) than those who did not. Those who had high perceived susceptibility were also three times more likely to get anxiety (aOR = 3.14; 95% CI = 1.14–8.57; $p = 0.026$) compared to those who had low perceived susceptibility. In addition, those perceiving a negative stigma were six times more likely to get anxiety (aOR = 6.25; 95% CI = 1.8–21.6; $p = 0.004$) than those who did not.

Factors Predicting Depression Among Indonesian Migrant Workers

Table 4 presents the unadjusted and adjusted odds ratio of factors linked with depression during COVID-19. An adjusted analysis found being a university graduate and doing 14-day quarantine were associated with lower depression. Those who graduated university were less likely to get depression by 77% (aOR = 0.23, 95%CI: 0.09–0.61; $p = 0.003$) compared to high school graduates. Moreover, those who underwent the 14-day quarantine were also 87%less likely to get depression (aOR = 0.13, 95%CI: 0.02–0.69; $p = 0.017$) compared to those not doing quarantine. On the other hand, those who perceived negative stigma were 11 times more

TABLE 1 | Sociodemographic characteristics of Indonesian migrant workers and COVID-19 related experiences (*n* = 335).

Variable	*n* (%)
Gender	
Male	270 (80.60)
Female	65 (19.40)
Age group (year)	
<20	16 (4.78)
21–30	151 (45.07)
31–40	127 (37.91)
>41	41 (12.24)
Educational attainment	
High school graduated	81 (24.18)
University graduated	254 (75.82)
Marital status	
Single	151 (45.07)
Married	184 (54.93)
Working experience (year)	
<1	45 (13.43)
1–5	141 (42.09)
>5	149 (44.48)
COVID-19 status	
Negative	328 (97.91)
Positive	7 (2.09)
Compensation from company	
No	181 (54.03)
Yes	154 (45.97)
COVID-19 test history	
Never	45 (13.43)
Rapid-test only	142 (42.39)
Swab-test only	59 (17.16)
Both rapid and swab	89 (26.57)
Doing 14-day quarantine	
No	34 (10.15)
Yes	301 (89.85)

TABLE 2 | The HBM constructs and psychosocial factors of Indonesian migrant workers (*n* = 335).

Variable	*n* (%)
Perceived health status	
Good	254 (75.82)
Bad	81 (24.18)
Perceived severity	
Low	207 (61.79)
High	128 (38.21)
Perceived susceptibility	
Low	186 (55.52)
High	149 (44.48)
Cues to action	
Low	188 (56.12)
High	147 (43.88)
Response-efficacy	
Low	199 (59.40)
High	136 (40.60)
Perceived social support	
Low	185 (55.22)
High	150 (44.78)
Social trust	
Low	180 (53.73)
High	155 (46.27)
Have you ever experienced any rejection?	
No	225 (67.16)
Yes	110 (32.84)
Perceived stigma	
Positive	156 (46.57)
Negative	179 (53.43)

likely to get depression (aOR = 10.9; 95% CI = 3.02–39.37; p = 0.000).

DISCUSSION

The results of this study provide meaningful findings to help policymakers and program developers to address the main factors that might influence the mental health status of the repatriated Indonesian migrant workers. This study found that the prevalence of anxiety, depression, and stress among migrant workers was 9.25, 10.15, and 2.39%, respectively. This was relatively lower than the mental health problem among the general population during the epidemic situation, which was about 30.3% for depression, 36.1% for anxiety, and 32.1% for stress (29). Furthermore, this prevalence is also relatively low compared to healthcare workers, about 24% of whom report depression, 30% anxiety, and 40% stress (30). This is surprising

as we expected higher levels of anxiety, depression, and stress due to the difficult situation experienced by the repatriated migrant workers during the COVID-19 pandemic. Reasons for the differences could come from differences in the instrument used in the studies, socio-demographic characteristics, and recruitment strategy.

The present study found that the younger age group was associated with higher anxiety, similar to the findings in Austria among the general population during the COVID-19 lockdown (31). Additionally, the current study also found that higher educational attainment was linked with lower anxiety and depression. Different levels of knowledge and experience on coping strategies might explain why the older age group and those with a higher educational attainment have lower anxiety and depression (32). Furthermore, this is because the younger age group experiences a range of changes in transition in behavior, education, and social and developmental challenges. The addition of mental health-related COVID-19 escalates mental illness among these age groups. Married people have lower anxiety compared to unmarried in the present study, which might be related to better social support from their partner or family (33, 34).

Variable	Unadjusted		Adjusted	
	OR (95% CI)	p-value	aOR (95% CI)	p-value
Gender				
Male (R)	1			
Female	0.66 (0.28–1.56)	0.347		
Age group (year)				
<20 (R)	1		1	
21–30	0.14 (0.04–0.49)	0.002	0.27 (0.03–0.91)	0.039
31–40	0.23 (0.07–0.77)	0.017	0.85 (0.13–5.37)	0.862
>41	0.31 (0.07–1.25)	0.100	3.25 (0.35–30.47)	0.303
Educational attainment				
High school graduated (R)	1		1	
University graduated	0.34 (0.16–0.73)	0.006	0.30 (0.10–0.89)	0.030
Marital status				
Single (R)	1		1	
Married	0.42 (0.19–0.90)	0.026	0.14 (0.03–0.58)	0.007
Working experience (year)				
<1 (R)	1		1	
1–5	0.41 (0.16–1.02)	0.057	0.86 (0.22–3.38)	0.829
>5	0.26 (0.10–0.69)	0.007	0.22 (0.04–1.05)	0.058
COVID-19 status				
Negative (R)	1		1	
Positive	4.12 (0.76–22.2)	0.099	4.64 (0.37–58.17)	0.234
Perceived health status				
Good (R)	1		1	
Bad	4.55 (2.13–9.73)	0.000	2.85 (1.02–7.99)	0.046
Perceived severity				
Low (R)	1			
High	1.37 (0.65–2.89)	0.404		
Perceived susceptibility				
Low (R)	1		1	
High	2.89 (1.31–6.34)	0.008	3.14 (1.14–8.57)	0.026
Cues to action				
Low	2.03 (0.91–4.56)	0.085	0.44 (0.08–2.32)	0.330
High (R)	1		1	
Response-efficacy				
Low	2.53 (1.06–6.05)	0.037	1.37 (0.26–7.28)	0.711
High (R)	1		1	
Compensation from company				
No	1.20 (0.57–2.53)	0.636		
Yes (R)	1			
COVID-19 test history				
Never (R)	1		1	
Rapid-test only	0.44 (0.18–1.09)	0.077	2.36 (0.37–15.11)	0.366
Swab-test only	0.29 (0.08–1.02)	0.053	1.66 (0.22–12.42)	0.622
Both rapid and swab	0.19 (0.05–0.65)	0.008	0.49 (0.06–3.08)	0.497
Doing 14-day quarantine				
No (R)	1		1	

(Continued)

Variable	Unadjusted		Adjusted	
	OR (95% CI)	p-value	aOR (95% CI)	p-value
Yes	0.27 (0.11–0.66)	0.004	0.16 (0.03–0.98)	0.047
Perceived social support				
Low	3.05 (1.27–7.28)	0.012	2.69 (0.62–11.69)	0.186
High (R)	1		1	
Social trust				
Low	2.26 (1.00–5.06)	0.048	0.83 (0.22–3.10)	0.777
High (R)	1		1	
Have you ever experienced any rejection?				
No (R)	1		1	
Yes	2.06 (0.98–4.34)	0.057	1.93 (0.65–5.72)	0.237
Perceived stigma				
Positive (R)	1		1	
Negative	2.73 (1.18–6.29)	0.019	6.25 (1.81–21.57)	0.004

A study in China during the early point of the pandemic found different effects of quarantine on mental health status. An initial report revealed that quarantine was not related to mental health problems (35), as opposed to other studies which reported the risk of mental health problems (36). This study indicated that undergoin a 14-day quarantine was associated with lower anxiety and depression. These results might be related to the different sociodemographic situations, although is open to research to confirm the conflicting findings. According to the quarantine policy in Bali, the 14-day quarantine was recommended in the form of self-quarantine or centralized quarantine. As 64% of respondents experienced the centralized quarantine, lower anxiety and depression among migrant worker might be related to better health services provided by the government during quarantine.

There was a significant association between perceived negative stigma and higher anxiety and depression in the current study. During the COVID-19 pandemic, the negative stigma from society was commonly found among health workers due to the higher risk of disease transmission among this group (37). In the context of the repatriated migrant worker in Bali, negative stigma might have occurred due to the higher number of imported cases and local transmission among these groups during the early COVID-19 situation (17, 18). Moreover, lack of knowledge and awareness related to COVID-19 in society could increase the negative stigma related to COVID-19 (38). The resistance and misconceptions to the illness and its public health measures could also be additional arguments (39).

This study found that bad perceived health status and high perceived susceptibility were linked with anxiety. This might be because the respondent who had poor health status perceptions and higher perceived susceptibility tended to suffer from a mental health problem, compared to the respondent who perceived their health status as good and had lower perceived susceptibility (40, 41). In addition, even though this study found that perceived social support was not significantly associated with a mental

TABLE 4 | Unadjusted and adjusted logistic regression analysis showing factors associated with depression during COVID-19 (n = 335).

Variable	Unadjusted		Adjusted	
	OR (95% CI)	p-value	aOR (95% CI)	p-value
Gender				
Male (R)	1			
Female	0.76 (0.33–1.76)	0.522		
Age group (year)				
<20 (R)	1			
21–30	0.41 (0.10–1.62)	0.203		
31–40	0.58 (0.15–2.27)	0.435		
>41	0.34 (0.06–1.91)	0.222		
Educational attainment				
High school graduated (R)	1		1	
University graduated	0.31 (0.15–0.64)	0.002	0.23 (0.09–0.61)	0.003
Marital status				
Single (R)	1		1	
Married	0.47 (0.23–0.97)	0.043	0.42 (0.16–1.15)	0.093
Working experience (year)				
<1 (R)	1		1	
1–5	0.37 (0.15–0.95)	0.039	0.52 (0.15–1.83)	0.308
>5	0.38 (0.15–0.97)	0.042	0.45 (0.12–1.78)	0.258
COVID-19 status				
Negative (R)	1		1	
Positive	3.70 (0.69–19.85)	0.127	4.05 (0.46–35.48)	0.207
Perceived health status				
Good (R)	1		1	
Bad	2.81 (1.35–5.83)	0.006	1.58 (0.62–4.03)	0.342
Perceived severity				
Low (R)	1			
High	1.31 (0.64–2.68)	0.455		
Perceived susceptibility				
Low (R)	1		1	
High	1.67 (0.82–3.40)	0.161	1.96 (0.79–4.87)	0.150
Self-efficacy				
Low	1.13 (0.55–2.32)	0.738		
High (R)	1			
Cues to action				
Low	2.41 (1.05–5.48)	0.037	1.70 (0.56–5.16)	0.348
High (R)	1		1	
Compensation from company				
No	1.89 (0.89–4.02)	0.097	1.67 (0.67–4.27)	0.271
Yes (R)	1		1	
COVID-19 test history				
Never (R)	1		1	
Rapid-test only	0.37 (0.14–0.95)	0.038	2.65 (0.48–14.53)	0.262
Swab-test only	0.45 (0.15–1.38)	0.164	2.74 (0.42–17.79)	0.291
Both rapid and swab	0.34 (0.12–0.99)	0.047	1.99 (0.34–11.78)	0.488
Doing 14-day quarantine				
No (R)	1		1	

(Continued)

TABLE 4 | Continued

Variable	Unadjusted		Adjusted	
	OR (95% CI)	p-value	aOR (95% CI)	p-value
Yes	0.31 (0.13–0.75)	0.009	0.13 (0.02–0.69)	0.017
Perceived social support				
Low	2.90 (1.27–6.62)	0.011	1.97 (0.50–7.80)	0.335
High (R)	1		1	
Social trust				
Low	2.23 (1.03–4.83)	0.042	1.16 (0.34–3.98)	0.814
High (R)	1		1	
Have you ever experienced any rejection?				
No (R)	1		1	
Yes	2.56 (1.25–5.23)	0.010	2.09 (0.82–5.38)	0.125
Perceived stigma				
Positive (R)	1		1	
Negative	7.65 (2.63–22.25)	0.000	10.90 (3.02–39.37)	0.000

health problem, other studies found that the support from family members, friends, and communities was essential to reduce mental health problems during COVID-19 pandemic (42). The level of support given and the socio-economic situation during the COVID-19 pandemic also matters substantially. This implies the need to improve on health services during quarantine and that health promotion should be implemented to reduce the negative stigma related to COVID-19. Emphasizing the needs of migrants to stay away from their family, ensuring mental and physical support, and providing basic needs and effective counseling were considered as comprehensive health services to reduce mental health problems (43). In terms of health promotion, the government should give clear, concise, and necessary information in a respectful way to reduce social stigma, including avoiding the negative impact of social media exposure related to COVID-19.

This study has the following limitations. As this study uses a cross-sectional approach with convenience sampling, it cannot imply causality and inference. The online survey which was based on self-report may be subjected to recall bias, self-bias, and a tendency to report socially desirable responses. Despite these limitations, this study contributes to the understanding of anxiety and depression among Balinese migrant workers. Lastly, further studies should consider exploring more about the mental health problems among migrant worker in more in-depth qualitative research. The results of this online survey could be used as baseline information to conduct qualitative studies in the future.

CONCLUSIONS

The prevalence of depression, anxiety, and stress among repatriated Indonesian migrant workers were relatively low compared to mental health problems among the general population and healthcare workers. However, the focus should be given to particular groups of migrants including those who had bad perceived health status, high perceived susceptibility, and

perceived negative stigma. Improving the health service during the quarantine and promoting general health was essential to reducign the mental health problems among migrant workers during the COVID-19 pandemic.

DATA AVAILABILITY STATEMENT

All data relevant to the study are included in the article or uploaded as Supplementary Information—No additional data is available. As part of ethical clearance, the raw data used to support the findings of this study are restricted by the Faculty of Medicine, Udayana University Review Board to protect research subject privacy.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Research Ethics Commission, Faculty of Medicine, Udayana University/Sanglah General Public Hospital, Bali

Province, Indonesia. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

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Requestioning the Indonesia Government's Public Policy Response to the COVID-19 Pandemic: Black Box Analysis for the Period of January–July 2020

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Objectives: Indonesia responded the COVID-19 pandemic slowly these last months. The recent reports shown that the rate performance of Indonesian government in handling COVID-19 posits at the 4th worst all over the world. Meanwhile, through responsive, strict, and strategic policy, some Asia countries pushed the elimination case by doing lockdown. This paper questioned how government respond this pandemic, tried to track down the unresponsive and slow decisions, and analyze them comprehensively trough policy system framework. Moreover, we also considered a few feasible and strategic recommendations to accelerate the pandemic responding.

Methods: To visualize the anatomy of problems in handling these pandemic responses, this work applied Easton's black box analysis in formulating and introducing public policy. The black box analysis would help us to portray and understood the interests, rationalities, and priorities behind introducing public policies which was implemented to handle this health problem. Besides, the policy triangle framework was used to analyze how environment influenced key actor in making decision.

Results: This analysis study discovered the conflict interests in formulating and implementing public policy in handling COVID-19. The public policies are negotiated, discussed, and formulated under black box that ignore transparency, and other good governance principles. Consequently, the substance of public policy represents a certain interest of policy makers, that may conflict with the others and often contradict to the constitutional-based public interests, that is public health. It was impacted the emergence of messy and uncoordinated institutions that implement the conflicted policies. Undeniably, this situation may spark counter-productive ways, attitudes, and actions of people in responding those ambiguous policies. Therefore, this work recommended revising the coherences norms and public policies; reforming the ministry of health in public health's paradigm context; and improving the integration and coordination of cross related institutions, creating a single data on public health, and changing a new paradigm of people, including improving collective awareness in responding and handling COVID-19 appropriately.

Keywords: black box analysis, COVID-19, government, Indonesia, health policy review, public health emergency

INTRODUCTION

A new and threatening viral infection emerged in December 2019 and lead World Health Organization (WHO) to take serious steps to respond it. After some efforts, this global board assigned it as public health emergency (1). It also issued a public statement defining to be prepared by taking important measures to prevent the spread of the COVID-19 at local and national level. Through the Southeast Asian regional representatives, the WHO asked the countries to straight away to scale up all comprehensive efforts before the cases grow rapidly (1, 2).

Meanwhile, Indonesia government did not take the outbreak rapidly and seriously as evidenced by the dissemination of unclear and inconsistent information and unclear decisions. The Task Force Unit formed in March (3) and the first case appeared in the same month (4). Two months, amount of time passed by without a precise strategy to prevent the spread of COVID-19 in the country. Public could notice the government, attitudes, and statements that tended to minimize the scale of the problem and even asked them to take it easy. In the early time, the Government's warnings about the threat of news hoax were stronger compared to the alertness about the potential spread of the COVID-19.

Over 4 months since announcing its first case, the Indonesian government continually received sharp criticism for its inadequate efforts in dealing with the COVID-19 pandemic (5). The poor performance of the government was seen in some issues. One of them was the case numbers. The first cases are only two and the new case just appeared after 2 weeks later (4). Only in a month, the cases have been rising over 100 every month since last April. As of 31 July 2020, the official data confirmed 108,376 positive cases and 5,131 deaths (6, 7). Dealing with the outbreak surely needs a huge resource. However, out of the IDR 450 trillion budget prepared by the Central Government, the health sector only received IDR 75 trillion; as it turned out, most of the budget, as much as 150 trillion, was used for the recovery of the economic sector. All these raised questions about the Government's policy priorities and strengthened the opinion of some people that the establishment of the new normal at that time reflected the Government's tendency to save the country's economy first rather than focus on public health (8).

While the curve of COVID-19 cases continues to increase, the President of the Republic of Indonesia even announced that Indonesia would enter a new normal during which the country would have to learn to live with COVID-19, because the virus will not disappear (9). As a follow up on these directives, the Government then issued a new normal protocol (new normal) for offices and industries. This is considered an unfortunate development by some people, because the number of COVID-19 cases has not yet started to show a decline, and the determination of the so-called "new normal" is not entirely based on regulations from the WHO (10). Observations regarding the lack of integration and coordination as a measure of unpreparedness or government stuttering emerged not only in terms of data transparency, but also in many other things, including the ways by which several government institutions conveyed the risks through ongoing public communication. For example, it was about an Anti-virus necklace created by the Ministry of Agriculture and so on (11).

Regarding the current dynamics and facts showed the failures in handling the COVID-19 pandemic, it was the public policy that have power to control since early time. Public policy is a series of action taken or not taken by a government to solve public problems for the realization of public interest or to help people affected by the policy (12). Hence, the failure of public policies, including health policies, often becomes the basis for questioning the quality of such policies (13). National public policy setting takes place in the complexity of the process as a system, policymaking process as a system) (14, 15). Although intensively observed and analyzed, Easton (16) stated it still unclear how this governmental transformation process takes place in detail, and called this unclarity transaction process as *the governmental black box* (14, 15). Therefore, the purpose of this paper is to conduct policy analysis to answer and explain the following questions: (i) Is there stuttering and unpreparedness on the part of the Indonesian government in terms of taking action to prevent the spread of the COVID-19 pandemic in Indonesia based on the black box of policymaking process framework? and (ii) What recommendations can be given in the future for a better Indonesia?

MATERIALS AND METHODS

This study conducted by qualitative-interpretative approach. This method opened opportunities in using one or more ways for gathering, accessing or generating data: observing, with whatever degree of participating, interview in conversational mode; and the close reading of topic-relevant documents (17, 18).

We implemented a purposeful content analysis of available policy documents, programs, action plans, reports, press release, news related to COVID-19 in Indonesia, and from WHO. To select the valid data, documents and reports, we carefully picked from official website, for example: covid.go.id, kemkes.go.id, www.who.int, and many more credible ones. We also intentionally observed news with topics related to the study hypothesis with attention to objectivity. Therefore, we looked after information from national-scale media websites which release reports or news with the credible resource person, such as the President; the government representatives either from ministry, The Task Force Unit for COVID-19; or non-government coalition at the national level.

Regarding to the object of this scientific work, this is an analysis of public policy to gain alternatives and various implications for society. A public policy expert, William Dunn, wrote a definition of policy analysis as an applied social science discipline with various approaches to scientific methods and arguments to generate and transfer information relevant to policy so that it can be used as an effort to solve policy problems (13). Policy analysis is the activity of creating knowledge about and in the policymaking process, which includes researching the causes, effects, and performance of public policies and programs. The results of the analysis are then presented to public policy

FIGURE 1 | Analysis of Political System (David Easton, *A Systems Analysis of Political Life,* 1965). Source: researchgate.com.
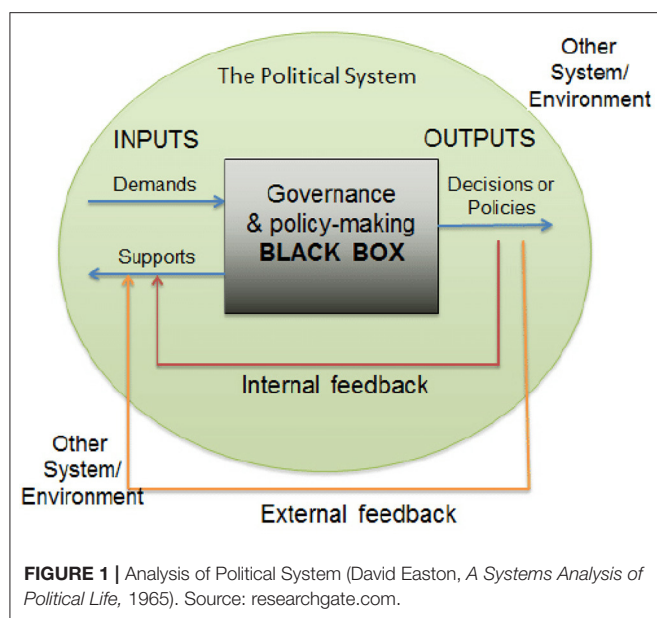
makers, who can use them to improve policy processes and performance (13).

The Conceptual Framework

This study used the black box design and health policy triangle as the conceptual framework to understand health policy system constructed the pandemic management and how key actors made decision.

Black Box-Based Public Policy in Handling the COVID-19 Pandemic

It is interesting to analyze public policies issued by the Indonesian government using the black box framework. This is because, like the black box in an airplane, which stores conversations in the cockpit and is used to reveal many secrets and their complexities in the aftermath of an airplane crash, the black box analysis can reveal the untold stories about the interrelations and dynamic interactions among elites and/or actors involved in the policymaking process.

Demands to the government and support from political parties and citizens become the inputs to the political system, as can be seen in **Figure 1** (13, 14). Then, based on these inputs, the process of giving responses or making policies (policymaking) is initiated in the political system, with outputs that give birth to decisions and policies. This point is known as a black box, a stage wherein the interaction process takes place between the demands and support of various actors involved to produce a policy output. Within a system, the output itself can later provide feedback and become an input for further policymaking. The output created by following a certain demand will give birth to new support for the system itself. However, if the policy outputs generated do not match, then the system's subsequent instability can open opportunities for policy revisions (13).

The framework of systems analysis in Easton's political science discussed above is in line with the cybernetics theory developed by Talcott Parson in his study of legal sociology. Also known as structural–functional theory, it posits the existence of four sub-systems in shared life, namely, cultural, social, political, and the economy, as interrelated components that influence one another. All components of this sub-system have specific roles and functions that influence one another, especially during the formulation of public policies. In more detail, it can be explained that culture has the weakest determinative energy in constructing economic, political, and social patterns despite the fact that it has the most information in shaping social, political, and economic patterns (19–21).

In several theoretical and practical political studies, it is often the case that certain groups—especially the political elites—try to influence public policies to make them more profitable for their party. Such efforts can be seen from their maneuverings and games of power (power exercise), including their behaviors in grabbing or pursuing power (power-seeking) (22). Given that the political process focuses on accommodating and allocating values, it does require a balanced exchange or reconciliation between social components. A reconciliation of the differences of interests and requests (demands) is required to achieve or maintain the stability and cohesiveness in a bargaining position, to determine the value allocation authority, and to identify the reason for the allocation, which occurred in a process known as the black box of policymaking (23).

RESULT AND DISCUSSION

Assessment of Policy Alternatives and Their Implications

Aspects of Transparency and Responsiveness

Indonesia is thought to be the country with the worst COVID-19 testing performance in the world after Bangladesh (24). Within 1 month of announcing its first case in early April 2020, Indonesia had only carried out 14,354 or 52 per 1 million population tests, far behind other countries in the same period (25). Based on data obtained in April 2020, Indonesia has only conducted examinations on 10 people per one million population (26) (**Figure 2**).

The WHO, through a release issued on 6 July 2020, also issued its criticism (27). The WHO stated that priority examinations with the gold standard polymerase chain reaction (PCR) should be conducted to detect new cases, namely, Patients Under Supervision (PDP) and Person Under Monitoring (ODP), rather than to confirm the follow-up examinations of patients before being declared cured and discharged. The WHO also found that the death rates of PDP and ODP patients were surprisingly higher than the death rates of confirmed cases of COVID-19 (26). The impact of the country's dismal performance and capacity when it comes to COVID testing has made Indonesia one of the countries with the highest death rate for health workers in the world, with a death rate of 2.4% of the total 89 health worker deaths due to COVID-19 as of 13 July 2020. Indonesia is only trailing behind two countries, namely, Russia (4.7%) and Mexico
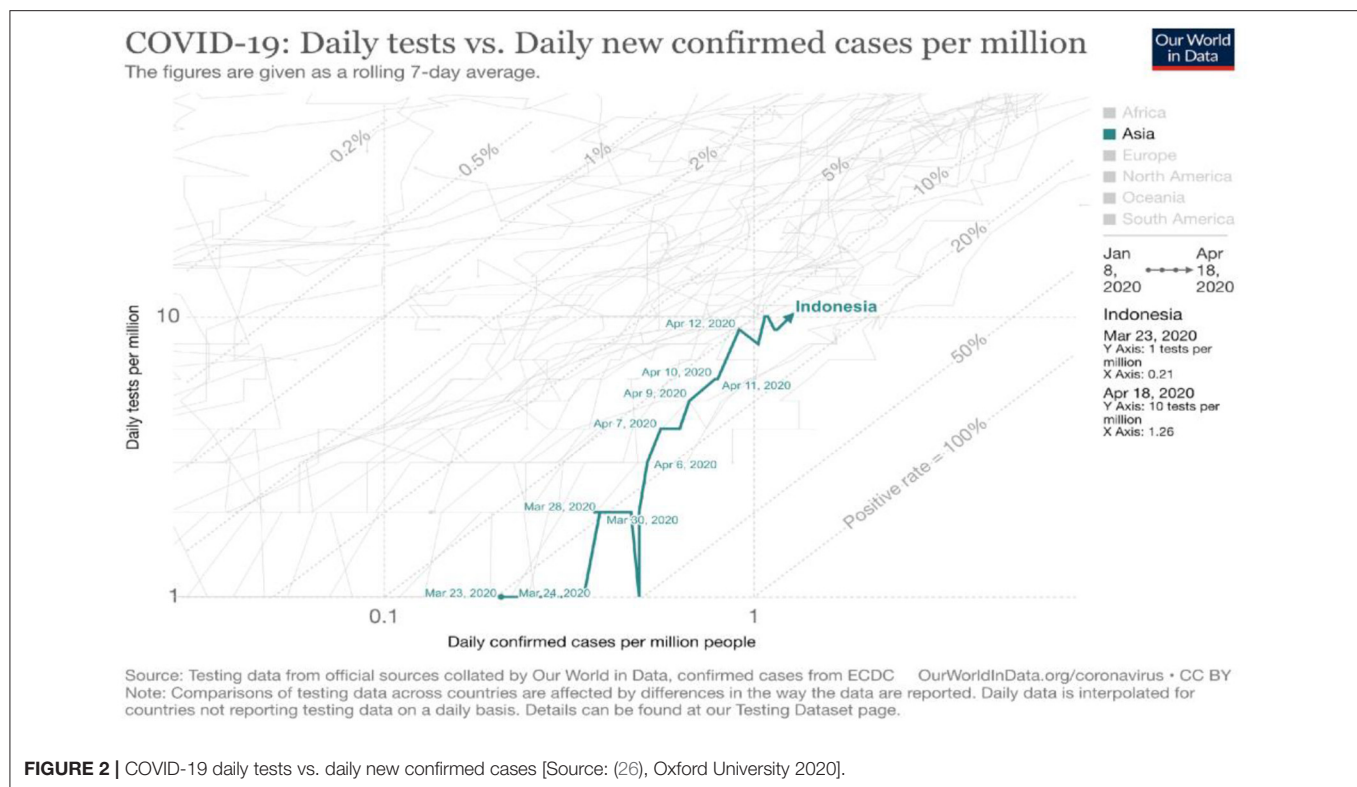
FIGURE 2 | COVID-19 daily tests vs. daily new confirmed cases [Source: (26), Oxford University 2020].

(2.8%). As of August 1, several health professional organizations in Indonesia recorded that the number of health worker deaths due to COVID-19 had increased to a total of 153 cases (28).

About the Indonesian government's stuttering in handling the pandemic was allegedly due to the uncomplete, a unintegrated of the data. Surprisingly, concerning data transparency, the President admitted that the Government had deliberately not disclosed all data in the early months of the pandemic because it did not want to cause public anxiety and panic (29). The Government's non-transparent attitude has sparked the concern of many parties, including a non-government coalition (30). The representative person even said the way the government provides this information is far from fulfilling the constitutional rights of society. The transparency is an important turning point to create public trust and willingness to be involved and actively participated in dealing with this pandemic. However, it has been only a month since the previous announcement, The President through the Government Spokesperson for COVID-19 conveyed to the central and regional governments to be transparent to each other. The President further asked all relevant stakeholders to carry out effective, detailed, and transparent communication to all parties. The disclosure of the data should also be eventually integrated into the Acceleration Handling Task Force COVID-19 (31).

The difficulty in ensuring data transparency has significant consequences. On June 24, the Chairperson of the Expert Team for the Task Force for the Acceleration of Handling COVID-19 conveyed the results of Indonesia's work against COVID-19 for the past 3 months. The organization demonstrated a system called *Bersatu Lawan Covid* (BLC) or United Against Covid, which collected various data on handling the COVID-19 outbreak from the Ministry of Health (MOH), including data from Hospitals Online. Research Agency Network Laboratories and the Health Development, as well as the Public Health Emergency Operating Center under MOH. Data from BLC showed that the number of patients who died reached 11,477 people (51.5 people per 1 million population) (32). On the same day, however, the government spokesperson for handling COVID-19 reported on a live broadcast that the death rate was 2,500 people (14 people per 1 million population), placing Indonesia as the country with the highest death rate in Southeast Asia (32). The difference in the official data announced by the Government is ironic.

This is because even before the COVID-19 pandemic occurred in Indonesia, the *Satu Data Indonesia* (SDI) program—a programs that integrate data from multiple sectors as implementation of Presidential Regulation (PERPRES) Number 39 of 2019—was already launched to regulate the synergy between ministries/ agencies, central and regional, as well as government and society in implementing development (33). Thus, in this case, even though the aim of this program is to improve data governance to produce accurate, up-to-date, integrated, and accountable data, it has failed to become the foundation for effective and targeted policymaking for COVID-19.

The government spokesman for COVID-19 efforts also repeatedly issued controversial statements, thereby indicating the government's weak risk communication regarding the pandemic.

One of the things that had caused a complicated controversy was the statement: "*Yang kaya melindungi yang miskin agar bisa hidup dengan wajar, dan yang miskin melindungi yang kaya agar tidak menularkan penyakitnya*" (The rich people protect the poor so they can live properly, the poor protect the rich so they do not spread the disease) (34). Following the absence of data on the number of ODP and PDP deaths, the spokesperson defended this by saying that the WHO did not ask for this data, so they did not feel the need to report. Sources from the Task Force said that even in the early days of the pandemic, the Task Force failed to obtain detailed data on the conditions of the outbreak, even though such data were very much needed to monitor the pandemic conditions and determine the next steps to be taken. Unfortunately, the slow integration of data has had complicated, far-reaching consequences for patient mapping, COVID-19 response, public trust, and most importantly, the possible protection of human lives (32). Several parties, including the London School of Hygiene and Tropical Medicine UK, have modeled estimates that there are far more positive cases of COVID-19 in Indonesia than that reported by the Government, which is only about 4.5% (35).

Rationality of Prioritization

Yet, even as the curve of COVID-19 cases continues to increase, the President of the Republic of Indonesia has announced that the country will enter a new normal. The implementation of this new normal is regulated in the Decree of the Minister of Health Number HK.01.07/MENKES/328/2020 concerning the Guidelines for the Prevention and Control of COVID-19 in Office and Industrial Workplaces in Supporting Business Continuity in Pandemic Situations (36). The Ministry of Home Affairs also issued Decree Number 440-830 of 2020 concerning the Guidelines for the New Productive and Safe COVID-19 Normal Order for State Civil Servants within the Ministry of Home Affairs and Local Governments. This latest directive was issued even though the country has yet to meet some of the requirements delineated by the WHO for a country to create a new normal scenario, which include the following (10):

1. Evidence showing that COVID-19 can be controlled;
2. Capacity of health and public health systems, including hospitals, to identify, isolate, test, trace contacts, and quarantine;
3. Evidence that the risk of COVID-19 is minimized among vulnerable populations, especially in nursing homes, mental health facilities, and communities living in crowded areas;
4. Evidence that preventive measures are implemented in workplaces, including physical distancing, hand washing facilities, and other hygiene protocols;
5. Evidence that the risk of imported cases has been well-managed; and
6. Evidence that people have a voice and are involved in the new normal life.

Based on data from the WHO, until 8 July 2020, there was not one single province in Java Island, except for Banten Province, which had shown a drop in cases of at least 50% over the past 3 weeks since the peak of the last cases (27). The only province in Java that had reached the minimum detection rate was DKI Jakarta Province. This meant that the discourse and direction of easing policies to enter the era of a new normal were issued even though the emergence of new cases had not slowed down and the curve had not even sloped at all.

The accusation that the policy for handling COVID-19 was a "trade-off" between the interests of public health and the economy cannot be dismissed at the time of the determination of the new normal, which some parties believed was issued too quickly (37). The assumption that the Government is more concerned with the economy than the health sector is also associated with the view regarding the inadequate funding allocated for handling COVID-19 compared to other countries. The determination of the new normal under inappropriate situations and conditions has led some people to think that the Government is more concerned with the economy than the health sector. Furthermore, the budget allocation in our national expenditure budget is more focused on saving the economy by helping people whose incomes have been reduced or lost and by ensuring the availability of necessities. Indeed, public health in Indonesia, as a basic prerequisite for life, is not yet a priority for the Government. In fact, on March 31, the Government decided to increase the budget for financing pandemic response with a focus on economic recovery; from IDR 405.1 trillion, IDR 110 trillion was allotted for social protection, IDR 70.1 trillion for tax incentives and stimulus for People's Business Credit, and IDR 150 trillion for financing the national economic recovery program (37).

Some scholars have attempted to explain this phenomenon using the classical conceptual framework proposed by Wagstaff (38) regarding the poverty–health vicious cycle, which explains that poor health conditions affect the economic status of individuals through a loss of income and increased vulnerability to health care costs. Conversely, poverty causes health to also become worse, because the poor are vulnerable to suffering from various types of health problems (32). In relation to this, Indonesia's budget allocation strategy received criticisms, because it demonstrated that the Government was not focused on ensuring public health and safety against the threat of this pandemic. Despite the financial aid prepared for informal workers, such as day laborers, the benefits will be lost if they contract COVID-19 (33, 34).

Inter-institutional Coordination and Integration

A few weeks after the term "new normal" was used in the context of loosening the PSBB to revive the sluggish economy, the Government then stated that such a term, which had been used so far, was incorrect. In fact, the term "new normal" is not sufficiently understood by the public. It makes the people focus only on the word "normal" when the actual situation is far from normal; worse, some even mistakenly interpret it as the return to old normal. Instead, the term should be interpreted as an adaptation of behaviors to the current situation. The behavioral adaptations in question include maintaining social distance, wearing masks, and washing hands frequently with soap, which

are intended to limit or prevent further transmission. The public is asked to accept the fact that COVID-19 is still around us, but that people should feel that they are no longer at risk.

The consideration of the condition of public understanding and acceptance of the term "new normal" may have driven the Government to no longer use the term, and replace it instead with "adaptation to new habits." The issuance of the policy on the use of this new term can be viewed positively, indicating the Government's willingness to make policy improvements. However, the rectification of this term also makes it appear that the Government "recognizes" its unpreparedness in various matters, including the determination of previous policies (35).

The issue of coordination and integration between agencies and ministries was retested in another incident. The curve of the number of cases began to increase quite sharply in relation to the observance of religious holidays in Indonesia. Indonesian people have a strong homecoming tradition during the Eid al-Fitr holiday, and they observed this even amidst the pandemic. At first, the Government had encouraged the people not to go home or return to their hometowns for this year's Eid celebration, mainly through a song sung by state officials entitled *Ojo Mudik.* This is important, because the mobilization of the majority of the population in the capital can cause the spread of COVID-19 to remote areas. Families in their hometowns also faced a high risk of receiving migrants from the city.

Unfortunately, the promotion carried out by these officials crumbled with a statement from the President in mid-April: "*Kalau pulang kampung boleh, mudik tidak boleh*" *(Back to home is permitted, homecoming is not)*" (36). This statement showed similar two terms that refer to situations where people will travel and increase the risk of transmission of COVID-19. It made confuse and difficult for many parties in the field because many people ended up deceiving the officers by taking advantage of the President's statement, whereas the Government had previously declared a ban on people from the regions to implement PSBB. Arguably, the confusion and ambiguity arising from this policy may have been responsible for the further increase in COVID-19 cases in Indonesia. This improper risk communication has led to the lax supervision of travelers from the capital. For example, on the Bandung–Tasikmalaya–Ciamis route, checkpoints for officers were visible, but at certain hours, there were no checks and even no officers. Thus, people who went home, carrying homecoming equipment on two-wheeled vehicles were free to drive in the area.

Another example that can be related to the Government's perceived stuttering in terms of the coordination between agencies and ministries during a pandemic is the continued implementation of the UTBK (Computer-Based Written Examination) last July. The UTBK was even held in areas with very high COVID-19 cases, including Surabaya. Thankfully, several local governments, such as that in South Tangerang, Banten Province, decided to postpone the UTBK, because they were still implementing PSBB. Of course, local governments that continued to hold UTBK exerted efforts to implement health protocols. The Surabaya local government, for example, implemented a free rapid test policy for students holding KIP as a step toward preparing for the UTBK implementation (10). However, criticisms regarding its effectiveness have

been raised, because rapid tests are considered an inadequate measure to assess whether a person is truly safe from the COVID-19 infection. This situation reflects the perspectives of responsiveness, priority setting, and integration among government agencies, including the Ministry of Education and the Ministry of Health, as indicators of whether or not the Government is ready to deal with the COVID-19 pandemic in Indonesia.

Structure-Function and the Leadership Role of the Ministry of Health

Determining the Status of Public Health Emergencies through Presidential Decree No. 11 of 2020, which concerns the Determination of Public Health Emergencies related to COVID-19, is a long-awaited regulation and is a relief for many parties. Nevertheless, it still raised criticisms because it only appeared several months after the WHO declared a public health emergency in January. Unfortunately, news emerged in the mass media that between these periods, several statements from the Government were considered counterproductive to the pandemic response, such as statements that you do not need to worry too much and just enjoy facing a pandemic and that there is no need to wear a mask if you do not get sick. More dangerous than the COVID-19 itself were statements that this was just a news hoax, which unfortunately came from institutional leaders and national level public officials closely related to the health sector. Needless to say, such statements affected the public's sense of crisis and urgency regarding the imminent dangers brought on by the transmission of the COVID-19.

Public assessment of the slow pace of government action, among others, also began with the implementation of Government Regulation No. 21 of 2020 concerning the Large-Scale Social Restrictions (PSBB) in the Context of Accelerating Handling of COVID-19, whose derivative regulations were stipulated in Permenkes No. 9 of 2020. This regulation positions the Ministry of Health as a party that will approve the submission of the local government for the determination of the PSBB status. However, different regional capacities in fulfilling various requirements and the formal administrative process for submitting PSBB may cause delays in its application, which is unfortunate because the situation is an urgent one. The PSBB is expected to reduce the curve of COVID-19 cases, but the reality on the ground does not work that way. For example, even before the policy of the central government related to PSBB was implemented, some provinces, including Papua Province, first initiated a lockdown by closing all access in and out of the province, in response to the provincial government's call to protect its citizens.

The focus of the policy strategy on public health resilience is not yet strong in terms of the function, structure, and leadership role of the Ministry of Health. That the responsibility of initial efforts to prevent, detect, and respond falls on the regional governments indicates the lack of robustness of the efforts implemented by the Ministry of Health. Delays in handling from the start can be a reflection of the less than optimal function, structure, and role of the Ministry of Health in terms

of public health resilience. In fact, in a public health emergency, the public health paradigm (public health law) should be the commander who leads the issuance of various policies, strategies, and programs for overcoming COVID-19.

The PSBB is one of the policies issued in response to public health emergencies. Efforts to tackle the COVID-19 pandemic aim to ensure that Indonesia can develop strong capabilities in preventing, detecting, and responding to various threats to global health security. Therefore, in line with the GHSA agenda, the Indonesian government needs to place public health resilience (part of national security) as a top priority in every policy implementation in order to effectively respond to the COVID-19 pandemic.

Therefore, it is very unfortunate that in this situation of public health emergencies, there remains a continued scarcity of tools, facilities, and infrastructure for handling COVID-19, and even the active participation of various levels of society to collect donations to buy supplies cannot help augmenting these shortages. For instance, the shortage of personal protective equipment (PPE), which are urgently needed by medical personnel, is exacerbated by the high prices of supplies (e.g., masks, alcohol solutions, hand sanitizers, etc.) and essential PPE, such as hazard material suits, the price of which has increased by 20 times due to hoarding by speculators and opportunists, revealing the existence of a medical equipment mafia. The Government's weak response in ensuring the availability of much needed logistics (26) reflects the capacity and effectiveness of the Ministry of Health's leadership, structure, and function, which are greatly tested in this context.

Various policy choices and their implications, according to the framework of the policymaking process remind us of the political behaviors of elites/policymakers as an important factor influencing policy output (e.g., explaining why policies frequently change or are revised). Departing from this concept, we use a system approach to analyze these elites/policymakers as a component of policies for handling the COVID-19 pandemic in Indonesia.

The **Table 1** shows the process of determining government policies to face a pandemic, according to Kivits. It explains the dynamics of stakeholders and their respective positions in the framework of power and urgency. The discussion of stakeholders and their relations to the influence of power and urgency is a very dynamic concept that can change rapidly as long as the policy lasts (37). For example, when stakeholders are exposed to coercion, whether under normal conditions or not, that power can be sought but can also disappear.

The first factor in Mitchell et al.'s (39) model is power: when a stakeholder has access to coercive, utilitarian, or normative means of power, it can impose its principles onto the relationship. Access to power, or the means to exert power, is often variable and is not in a steady-state (40). Power may be gained, as well as lost, over time. Within the stakeholder relationship, it is therefore important to be aware of the power relationships between stakeholders and how these relationships might change over time (34). This also determines the degree of importance attached by stakeholders to

certain issues; thus, the degree of importance varies for each stakeholder.

The description of elite interaction in the determination of policies for handling the COVID-19 pandemic, as described in the **Table 1** shows the birth of public policies that take place as a system, with several internal and external factors influencing its determination. Models that identify several factors that influence the political behavior of individual political elites can be visualized in the following combinations of approaches: (i) indirect socio-political environment, such as political systems, economic systems, cultural systems, and mass media; (ii) the direct socio-political environment that influences and shapes elite personalities, such as family, religion, school, and social groups; (iii) personality structure, which is reflected in individual attitudes; and (iv) direct socio-political environment factors in the form of situations, namely, conditions that directly affect actors when they want to carry out an activity (41). The roles and positions of the WHO, Community/Religious Leaders, NGOs, Academics, the President, DPR, BNPB, Entrepreneurs, and Local Governments as actors or elites in determining policies to handle the COVID-19 pandemic are directly or indirectly influenced by environmental and structural factors.

Therefore, realizing how dynamic power relations take place is very important in mapping out the socio-economic power in the policymaking environment; in this way, the outputs of policies take into account the support resources and the demand they have. Furthermore, the policymaking process should take place with an awareness of the phenomenon of the black box of policymaking; it should not only be dominated by the narrow interests of political elites who bargain for positions and interests. For example, economic interactions between the government and the business sector can be seen in the tourism incentive policies issued during the pandemic. This policy, which is diametrical, contradicts the rationality of handling COVID-19. In other words, while other countries in the world are struggling to mitigate the effects of COVID-19 pandemic, the Indonesian government has allocated a budget of up to IDR 72 billion for foreign influencers to promote tourism and to increase flight escalation and interactions. It cannot be denied that this government policy shows the dominance of economic considerations without considering the country's ability to face a pandemic (33). Snippets of the main policies issued by the Government in dealing with the COVID-19 outbreak in the following table can also be understood using the black box of policymaking approach.

The Government must optimize the function and role of the Ministry of Health in preventing, detecting, and responding to the disease. In handling this pandemic, the Government has positioned the National Disaster Management Agency (BNPB) in the front line, in collaboration with the Ministry of Health and with support from other ministries and state agencies. Institutionally, the Ministry of Health's task is not only to issue a PSBB policy but also to prepare and formulate health policies so that the pandemic will end quickly (42). Normatively, the analysis of government policies in overcoming the COVID-19 pandemic in Indonesia can be reviewed in relation to the global standard regulation, namely, the IHR 2005 issued by WHO and ratified by

TABLE 1 | Analysis of Easton's system component mapping (input-process-output-environment).

Elite/policy actor	Positioning/expected roles of actors	Positioning/roles of actors in reality	Support/demand/ resources
WHO	• Direct and coordinate local and international authorities in health efforts • Determine standards and guidelines • Coordinate international responses to public health emergencies • Assist the national government in improving health services • Cooperate with other specialized agencies if necessary • Provide health assistance to countries in need • Encourage and assist the implementation of research	• Diplomacy and dissemination of the latest accurate information related to the pandemic is suspected of being biased against China • Determining COVID-19 to be PHEIC is a bit late than it should be • Ensure that vital supplies reach health workers • Conduct training and mobilization of health workers through the platform Open WHO Leadership • Identify research priorities in the search for vaccines	Authority
Community/Religious Leaders	• Help communities avoid hoaxes and misinformation • Help convey health messages • Help remove the stigma focused on a group of people • Able to shift community actions in the desired direction • Become a pattern for the community to behave in the "right" life, including in terms of healthy living behavior during the pandemic	• Keep holding the *Ijtima Ulama Dunia* in Gowa, South Sulawesi, during the pandemic • Issue fatwas related to the implementation of worship during the pandemic • Allow Eid and Eid al-Adha prayers in houses of worship/fields in the COVID-19 (Islam) free zone, and appeals to carry out worship from home (non-Islamic) • Raise funds for victims affected by the pandemic • Issue guidelines/protocols of worship in houses of worship during the *new normal* era	Community trust
NGOs	• Fight for community aspirations • Social control of problems • Raising social and environmental issues	• Government advocacy to improve response to the pandemic • Establish a task force for handling COVID-19 within their respective organizations • Utilize organizational resources to help communities in need • Provide education and dissemination of important and accurate information related to the pandemic • *Crowdfunding* to help fulfill various funding needs (e.g., PPE) • Develop research related to pandemics	Organizations Social control
Higher Education/Research Institutes/Academics	• Input on government policy directions • Socialization and public education • Conduct pandemic-related research	• Conduct webinars, trainings, and scientific discussions to help solve pandemic-related issues • Conduct various research (e.g., medical devices, vaccines, drugs, etc.) to help deal with pandemic-related issues • Engage as a *key stakeholder* for the government to determine the direction of policies, strategies, and programs for handling the pandemic	Human resources Policy brief
Government (President)	• Main regulator • Leaders and commanders/navigation related to pandemic response • Collaborate with other countries in resolving pandemics • Involve pentahelix in resolving pandemics	• Establish a task force to handle the pandemic • Approve bureaucratic flow, use of inappropriate terms, and delays in handling pandemics • Direct every state institution to rush efforts to deal with the pandemic	Authority Legislative Regulation
Dewan Perwakilan Rakyat (DPR)/Legislative Board	• Budgeting • Supervision	• Ratify bills that are not a priority for handling the COVID-19 pandemic • Do not carry out comprehensive supervision related to handling pandemics	Role and the authority of the policy making
Ministry of Health	Coordinators, regulators, and implementers (to a certain extent) related to the health aspects of the pandemic response	Delay in announcing pandemics • Notes on limitations and inaction in response to the pandemic in the early stage • Criticism of the principle of efficiency and effectiveness of M&E (monitoring and evaluation) in handling the pandemic	Authority Regulatory

(Continued)

TABLE 1 | Continued

Elite/policy actor	Positioning/expected roles of actors	Positioning/roles of actors in reality	Support/demand/ resources
Badan Nasional Penanganan Bencana (BNPB) National Board for Disaster Management	• Implementing core government policies trough integrating other many parties roles and data sources during the pandemic	• Providing guidance and direction for disaster management efforts covering disaster prevention, disaster emergency response, rehabilitation and reconstruction in a fair and equal manner.	Authority Regulatory
Ministries other institutions	• Support core policies from the government (president)		Authority Regulatory
Entrepreneurs	• Investment • CSR • Anticipation against possible policies that can affect the companies' economic sustainability	• Changing the pattern of business continuity during the pandemic • Helping people/employees who are affected by the pandemic • Carry out community service to help those affected by the pandemic	Capital Companies Manpower
Local Government	• Implementing policies at the provincial/district/city levels	• Stuttering implementation of top-down policies of the central government • Take initiative in handling pandemic-related issues • Conduct innovations that often do not have a good impact on the pandemic	Authority in the regional Regulations in region # Adjusting the central direction

Indonesia as a mandate to be implemented. The global agreement in the prevention of transnational diseases requires that each country must have adequate capacity, both in routine conditions and during public health emergencies, at ports, airports, and state land border crossings (PLBDN), especially in conditions that are designated as a public health emergency of international concern (PHEIC). The WHO has prepared assistance in the form of cooperation between countries in the evaluation, assessment, and capacity building of public health. Such an assistance also includes supporting countries in identifying sources of funds needed to develop and maintain the country's capacity. The enactment of this IHR (43) is typically followed by guidelines, instructions, and procedures to carry out routine inspections at ports, airports, and land borders (42). This 2005 IHR Agreement should be the basis of reference for the Indonesian government in formulating public policies in response to the spread of COVID-19.

At the national level, Indonesia is also bound by the Health Quarantine Act. Even before that, Indonesia has implemented Law No. 4 of 1984 concerning plagues; Law No. 24 of 2007 concerning Non-Natural Disasters, Epidemics, and Disease Outbreaks; and Law No. 23 of 2014 concerning the Sharing of Concurrent Affairs in the Health and Disaster Sector. Unfortunately, when the COVID-19 pandemic hit the world, Indonesia did not proportionally appreciate the various normative provisions above. Even at the level of implementation, Indonesia was considered inconsistent and stuttering in responding, formulating steps, or taking action to overcome the COVID-19 pandemic. This can be seen from the many regulations issued by the Government that complicated the handling of the pandemic, which caused uncertainty, instability, and confusion not only at the conceptual and administrative level but also at the level of implementation.

The analysis of various policy products as well as the roles and respective policy actors listed in the **Tables 1**, **2** constitutes

a policy review with a triangle of policy framework (content, process, and actors). However, the various complexities of the above problems can be deepened by using legal system theory introduced by Lawrence M. Friedman. This theory holds that the effectiveness of legal safeguards rests on at least three components of the legal system, namely, (i) legal substance, (ii) legal structure, (iii) legal culture. The three components in the legal system are important prerequisites for implementing all public policies (44). These three components must be interrelated and interact in a coherent manner. Otherwise, the incoherence among these three components can have negative implications and can lead to counterproductive government policies.

The large number of complex problems found in these three levels further reflects the ineffectiveness of policies for handling COVID-19 in Indonesia. An example of a problem at the structural level is the lack of synergy or coordination among institutions implementing the policies for handling COVID-19. The policies that have been made by the Government seem to be fading, for various reasons, so that even the officials at the scene of the incident are unable to take firm action against the people who violate the rules. This situation also reflects the weakness of law enforcement agencies and prevailing policies. Therefore, the Government's weak monitoring and evaluation of policy implementation indicates its inability to formulate a comprehensive and coherent legal substance.

Certainly, there are positive policies issued by the Ministry of Health that should be appreciated. For example, it initiated to increase ASEAN health sector cooperation in handling COVID-19 (45). This meeting resulted in the successful adoption of the Joint Statement of the ASEAN Health Ministers in increasing the collective response to COVID-19 in the ASEAN region. The Joint Statement outlines a commitment to continue to exchange data and information on the development of COVID-19 through established cooperation mechanisms, to coordinate contact tracing and case investigations through bilateral and

No.	Policy	Date in charge	Title	Responsible
1	Presidential Decree No. 7 of 2020	13 March 2020	Presidential Decree (KEPPRES) on the Task Force for the Acceleration of Handling of COVID-19	Task Force for the Acceleration of Handling COVID-19
2	Presidential Decree No. 9 of 2020	20 March 2020	Presidential Decree (KEPPRES) concerning the Amendments to Presidential Decree No. 7 of 2020 concerning the Task Force for the Acceleration of Handling of COVID-19	Task Force for the Acceleration of Handling COVID-19, Synergy between Ministries and Institutions
3	Presidential Decree No. 11 of 2020	31 March 2020	Presidential Decree concerning the Determination of Public Health Emergency COVID-19	Task Force for the Acceleration of Handling COVID-19,
4	Government Regulation No. 21 of 2020	31 March 2020	Government Regulation (PP) regarding the Large-Scale Social Restrictions in the Context of Accelerating the Handling of COVID-19	Ministry of Health
5	Presidential Decree (KEPPRES) concerning the Determination of Non-Natural Disaster for COVID-19 as a National Disaster	13 April 2020		Task Force for the Acceleration of COVID-19 Response
6	Permenkes No. 9 of 2020	3 April 2020	PSBB Guidelines for Handling COVID-19	Ministry, Local Government
7	SE Minister of Religion No. 6 of 2020	6 April 2020	Guidelines for Ramadan and Eid Al-Fitr 1 Syawal 1441 H in the Middle of the COVID-19 Pandemic	Ministry of Religion, Society
8	Kepmenkes No. HK.01.07/Menkes/382/2020 Year 2020	19 June 2020	Health protocol for People in Public Places and Facilities in the Context of the Prevention and Control of COVID-19	Ministry, Society
9	Joint Decree of the Minister of Education and Culture and Menparekraf No. 02/KB/2020 and No. KB/1/UM.04.00/MK/2020	02 July 2020	Technical Guidelines for the Prevention and Control of COVID-19 in the field of culture and creative economy during the determination of public health emergencies related to COVID-19	Stakeholders of education and tourism/creative economy
10	Law No. 2 of 2020	21 May 2020	The Stipulation of Government Regulation in Lieu of Law Number 1 of 2020 concerning the State Financial Policy and Financial System Stability for Handling the COVID-19 Pandemic and/or in the context of dealing with threats that endanger the national economy and/or financial system stability into Law -The Act	All components related to the financing during COVID-19 pandemic

regional mechanisms, and to share technical materials and mobilize resources in supporting national and regional health systems (45). However, in handling the COVID-19 pandemic, the BNPB appears as a "war commander," thus leaving the Ministry of Health far behind.

Another criticism is that there is a need to strengthen the focus of empowering public health as a basic value. It is fitting for the public health paradigm or the public health law to become the commander in charge of the issuance of various policies, strategies, and programs to overcome COVID-19, in line with the Presidential Decree/Perpres 81 concerning Public Health Emergencies. The Ministry of Health must play a major role in ensuring health resilience in Indonesia, strengthening the country's ability to prevent, detect, and respond according to the IHR 2005.

The criticisms that should be addressed not only to the government but to overall governance have to do with the questions of how the efforts to disseminate the public health paradigm in the mainstream have been carried out all this time, whether there has been a systematic process from upstream to downstream (including educational institutions), and whether there are any legal aspects and regulations that form the basis of public health policies to strengthen health resilience as part of national resilience, especially considering that the pandemic is a global threat and public readiness to face it is determined by health resilience. However, the development and strengthening of national health and resilience is not a short project but a long journey.

In order to support the Ministry of Finance deal with COVID-19, in March 2020, the Government prepared a budget of IDR 75 trillion for the health sector (44). This budget is part of the IDR 405.1 trillion stipulated in the government regulations in lieu of laws on financial policies and financial system stability. The funds will be used for protecting the health workers; securing adequate supply of PPEs; testing; purchasing of reagents, ventilators, and other needs; and providing incentives for frontline health

workers. However, until the end of June 2020, only 1.53% of the budget had been disbursed due to the constraints in the verification process and the slow bureaucratic flow, resulting in several health workers complaining about not receiving the incentives promised by the government. The disbursement of this budget also has a high potential for corruption, because its use and monitoring have not been implemented in a regular and transparent manner. In fact, the implementation of state financial management must be based on the principles of good governance, *one* of which is the element of transparency.

The priority setting aspect in policymaking should also be considered, because there are various factors that can change according to political conditions and pressures applied during the policymaking process. With this approach, the success achieved in determining policy priorities as well as the process and structure of decision-making will be more profound. In this context, we need a more evidence-based policy to respond to existing policy failures or success. Even though, many countries are not prepared to handle this sudden outbreak, referring to International Health Regulation State Party Annual Reporting (IHR SPAR) [44, 45]. Hence, we still could learn from certain country which successes in preventing the massive spreading of the virus. For example, Vietnam that was rapidly prevent the outbreak by providing isolation place, integrating data; and engaging scientists and experts to prevent the viral spread and eliminate cases [46]. In addition, similar situation in Indonesia might be seen in Italy where this pandemic turn into a disaster due to the highest number of death case. A scientific review mentioned that the profound obstacles were including how the leaders could not recognize the threat of this virus, then organized a systematic response to it [47]. Another study's result showed a related situation that early reports on the spread of COVID-19 and adequate risk assessment can help inform government representative in effort to combat its progression. From the two countries, it could be lesson learn that primary strategies which are integrating resources rapidly; and leading transparent and accountable policy making processes are leadership capacity reflection in handling this pandemic.

Thus, in the future, it is hoped that the policies made will be a collaboration of conditions in the real field and science-based policymaking [48]. The evidence-based public policy approach should be the basis in setting public health policy priorities, as it gives value to the importance of evidence (data and facts) in the formulation of public policies aside from opinions that are influenced by other interests, such as economy, politics, personal interests, power, and so on.

CONCLUSION

The analysis conducted above helps prove the hypothesis of this study: The Indonesian government is not fully ready to face the COVID-19 pandemic. The determination of the status of public health emergencies is usually a strong message that the public health paradigm and approach are the "commanders" leading the war against the pandemic. This is explained by the fact that this pandemic is a reflection of the public health situation.

Comprehensive and integrative handling should be emphasized, not only in health services but in other important aspects of behavior, environment (social, economic, political, cultural), and genetic factors (heredity) [48].

Apart from the diametrical policies above, the model and flow of communication and information as well as the system referral in the health service structure itself are not yet ready to face the COVID-19 pandemic. This can be seen from the processes and indicators in the health services, ranging from personal quarantine, hospital quarantine, and regional quarantine. To date, the PSBB's functions overlap with others, indicating the lack of adequate control, monitoring, and evaluation; thus, the implementation of PSBB is not optimal. The lesson that can be learned is the urgent need to review institutional structures so that they can develop a greater capacity for public health resilience. Enriching the Ministry of Health to become the Ministry of Public Health with systemic integration and a policy strategy approach should be seriously considered due to the urgent situation in the country.

Enforcement of public policies in handling COVID-19, whether in the form of the PSBB Law, government regulations regarding public health emergencies, or management of financial policies in handling COVID-19 and others, must not be contrary to the constitution. The ensuing public policies must not take away the fundamental rights of the people in maintaining the sustainability of daily life, making them a paradox of public policy. Therefore, the process of formulating public policies that are directly related to public health must be based on the principle of transparency, including the disclosure of accurate and correct facts, data, and information based on scientific reasons, public reason, public rationality or common sense.

The process of formulating and establishing government policies in dealing with the COVID-19 pandemic is taking place in a very dynamic and rapidly changing context. Many policy changes have not maximally considered the importance of public safety and health as top priorities. The influence of various interests, such as economy and politics, is still too dominant in the formulation and determination of government-led health policies. This situation can be explained by the delays, stuttering, and confusion among policy actors, officials and the communities (both at the central and regional levels) in anticipating, responding, addressing, and dealing with the spread of COVID-19, while the epicenter of COVID-19 continues to move to the regions. Institutional strengthening through the validity (scientific authority) and the credibility of public information related to the substance of handling COVID-19 determines the trust of all components of the nation and motivates everyone to move together.

Regardless evidence and theories supported. We are aware of the limitation of our study as analytical work. First, the idea was built at the beginning of the notification from WHO about a potential outbreak of a new disease. We expected that the government took a fast response through strategic decisions and technical instructions to prevent the entry of the new disease into Indonesia. Second, we conducted this study's hypothesis after seeing the government who took steps to deal with the new disease 2 months after the notification. This study could

not capture the possibility of significances the changes and responses from the government, so the approval of the hypothesis would only be relevant for the time being. Then, this review was written in the first 4 months of handling the pandemic in Indonesia with the many social restriction regulation. As a result, we encountered limited data, other source information, and methods as the triangulation mechanism.

Actionable Recommendations

The failure of policy development, starting from the formulation, implementation, and evaluation stages, accompanied by the lack of transparent and rational public policy principles as well as limited facilities, infrastructure, and human resource capacity in the field of public health, all have the potential to threaten public safety and health. Thus, several recommendations compiled by the author are as follows:

a. The Ministry of Health must be reformed the paradigm with strong Public Health principle. The word "public" shows that parting with the community becomes more secure. This also avoids the Ministry of Health's sole focus on the medical aspect and enable it to strengthen health resilience as part of national resilience efforts, especially in terms of prevention, detection, and response. This is in line with the 2005 IHR issued by the WHO and also shows Indonesia's real participation as a member of the GHSA troika.

b. Institutionally, the Government needs to re-examine and restructure the roles and functions of the Ministry of Health's

institutions so that they play a more substantive role and function in handling COVID-19 with a systematic and integrative public health approach. This is an important step in increasing the credibility of public health resilience.

c. The SDI program should continue to be the source of coordination and integration of the state, and assurance is the only key holder of health data within a clear and measurable line of command. This is expected to make data more adequate in preparing and strengthening infrastructure from all aspects in the field of public health, especially in responding to the COVID-19 pandemic.

d. The health paradigm should be strengthened, because the WHO determined the quality of the Indonesian government's response to public health emergencies. This means educating public health advocates to become policy influencers and intensifying their involvement so that public awareness about public health rights in addition to obligations can be significantly increased.

AUTHOR CONTRIBUTIONS

DA conceived the manuscript idea with the support of HH, RU, and SS. HH wrote the introduction part. DA and SS wrote the methodology and analysis, meanwhile SS collecting and concluding the findings. SS prepared the figures. DA collected and integrated all drafts to become a full manuscript. All authors contributed to the article and approved the submitted version.

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The Unintended Consequences of the Pandemic: The New Normal for College Students in South Korea and Taiwan

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This study attempts to compare the impacts of the coronavirus (COVID-19) pandemic on college students' lifestyles and mental health conditions in South Korea and Taiwan. As the COVID-19 outbreak has spread across the globe, it has brought significant changes to college campuses worldwide. College students have been heavily affected by the closure, as online learning has become increasingly common in higher education institutions. Using data collected from college students in South Korea and Taiwan in the spring of 2020, this study examines the effects of pandemic-related lifestyle changes on mental health conditions for college students in the two countries. The results were 3-fold. First, compared to college students in Taiwan, college students in South Korea reported greater decreases in time spent traveling, being with friends, eating at restaurants, and engaging in part-time employment, and greater increases in online shopping and ordering food for delivery. Second, college students in South Korea reported a higher level of worry, a greater possibility of contact with a person with COVID-19, and a lower level of happiness than did college students in Taiwan. Third, our findings indicate that social activities, including spending time with friends, were positively correlated with mental health conditions in South Korea and Taiwan. Comparing Korean and Taiwanese students' lifestyle changes and mental health conditions amid the pandemic, the study argues that the decrease in socialization and interaction under these new circumstances may be a significant factor that explains an increase in mental health issues in Korean college students compared to Taiwanese students, given the increase in confirmed COVID-19 cases in South Korea and the corresponding greater use of online teaching platforms there than in Taiwan.

Keywords: COVID-19, higher education, college student, lifestyle change, mental health, the new normal, South Korea, Taiwan

INTRODUCTION

As the coronavirus (COVID-19) outbreak has spread across the globe, it has had massive social and economic consequences and led to sudden lifestyle changes in the form of social or physical distancing (1). College campuses worldwide have been significantly impacted by the pandemic, as most governments have temporarily closed colleges and universities in an attempt

to contain the spread of COVID-19. College students have had to rearrange their daily lives and have been exposed to a completely new campus environment, with a wide variety of modalities being tried across countries. Meanwhile, the pandemic has posed an existential threat to college students' mental health.

An environmental change can result in mental health issues in vulnerable people when environmental stress affects their mood, thinking and behavior. The COVID-19 pandemic, which has disrupted daily life for people worldwide, may put people at greater risk for mental health challenges. Global pandemics cause emotional and health issues, and neuropsychiatric consequences for both infected patients and non-infected individuals (2–5). Studies have identified psychiatric symptoms such as anxiety, stress disorders, and depressive symptoms as consequences of a viral pandemic (5, 6). For example, during the SARS outbreak in Hong Kong, most people felt anxious and changed their social behaviors (6, 7).

Amid the COVID-19 crisis, symptoms of mental health conditions have become a growing concern, and college student populations are not an exception (3). Lockdowns and outbreaks occurring on college campuses may lead to a lack of social support, social and physical isolation, and the disruption of daily routines and activities, increasing college students' mental health problems. According to the results of the Healthy Minds Study survey (3), mental health conditions have affected college students' rates of stress and depression since the start of the pandemic. The report highlighted that over 50% of American college students were concerned about being infected by COVID-19, and nearly 90% were worried about their personal safety and security. Students also expressed a lower level of psychological well-being than they had prior to the outbreak of the virus (3). New research is investigating the effects of COVID-19 on students' mental health, focusing on different country contexts.

In terms of its impact on higher education, COVID-19 has triggered unfavorable mental health outcomes for college students. Studies from different countries have indicated that college students need more support or interventions to cope with stress and uncertainty during the pandemic. Huckins et al. (8) points out that American college students have decreased their physical activity and are going to fewer places while reporting an increase in anxiety and depression symptoms. Focusing on Bangladeshi students, Khan et al. (9) identify stress, anxiety, and depression as common symptoms among college students, with fear of COVID-19 infection as the main causal factor. In addition, studies of Chinese college students indicate that students are worried about their academic delay, negative economic consequences, and routines and activities of daily life (10). However, no studies to date have shown how COVID-19 affects college students' lifestyles and mental health conditions from a comparative perspective, especially in Asia.

This study attempts to compare the impacts of the COVID-19 pandemic on college students' lifestyles and mental health conditions in South Korea and Taiwan. The hypothesis of this study is that students' experiences may vary based on how different institutions and countries have reacted to the pandemic. Therefore, considering the new circumstances created by the COVID-19 crisis and the different policy responses to the pandemic in South Korea and Taiwan, the study aims to understand how lifestyle changes have impacted students' mental health in Korea and Taiwan during the COVID-19 pandemic.

Using data collected from college students in both countries, this study explores differences and similarities across the following three aspects of their experience in relation to the threat of COVID-19. First, we investigate whether students in the two countries face different issues related to mental health. Second, we examine whether students in the two countries have different patterns of lifestyle changes. Third, we examine whether the extent of lifestyle changes contributes to the mental health of college students in the two countries. In doing so, the study tries to examine the different scenes on college campuses and compare the unintended consequences of the pandemic for college students' lives in the selected countries from a comparative perspective.

POLICY RESPONSES TO COVID-19 IN KOREA AND TAIWAN

Until last August, both South Korea and Taiwan were among the few countries that had demonstrated success in curtailing the spread of the virus by adopting necessary measures to mitigate the impact of subsequent outbreaks (11). Capitalizing on their prior experience with SARS in 2002–2003 and MERS in 2015, both countries exhibited robust and consistent standard operating procedures (12). The governments' decisive actions early in the crisis achieved favorable outcomes, flattening the curve in both countries (13). More recently, the early gains in South Korea have given way to alarm as the country has faced an unstoppable wave of infections (14).

Taiwan took aggressive action to combat the outbreak as soon as the WHO reported the existence of a virus of unknown cause in Wuhan, China. Taiwan immediately closed off all travel from China, activated its Central Epidemic Command Center, began screening arrivals, and deployed detailed contact tracing, even before the World Health Organization advised such a step (15). The Entry Quarantine System was also launched, requiring travelers to complete a health declaration detailing their travel histories, specific symptoms, and health evaluations (16). Travelers were mandated to complete a 14-day home quarantine, which included self-isolation without going out or having visitors and recording temperature twice a day (17). Travel restrictions were implemented, and only those foreigners holding Alien Resident Certificates were allowed into the country (18). Finally, the government disseminated a health promotion message recommending handwashing routines and mask-wearing in crowded or enclosed places (17).

In South Korea, the situation was more challenging, as the country reported the second-highest number of confirmed cases of the virus after China between January and February when a cluster of cases was identified in Daegu, a city of ~2.5 million (11). After this peak, the number of confirmed cases declined rapidly, although occasional minor resurgences continued to occur. Korea's response to COVID-19 was seen as successful, as it was one of the first countries to quickly flatten the curve. Korea

managed to mitigate the pandemic by implementing widespread testing, contact tracing, and quarantines for all positive patients (15). Beginning in the early stages of the major outbreak, the government collaborated with the scientific community and directed companies to produce a diagnostic reagent. In April, Korea expanded its testing capacity to provide an average of 15,000 diagnostic tests per day (19). However, the virus spread through local communities, increasing the chances that the virus would spread over a wider part of the country, and the government announced that Level 2 social distancing, the second highest tier in a three-tier system, would be implemented in the capital area beginning in August 2020 (20).

The Korean government also adopted a nationwide contact-tracing program that combined traditional shoe-leather epidemiology with new methods that make efficient use of technology and large databases (i.e., global positioning systems, credit card transactions, and closed-circuit television) (21). People identified as having had contact with confirmed or suspected cases were asked to self-quarantine at home or in designated facilities, and as in Taiwan, mandatory 14-day quarantines were required for all travelers entering the country (19).

HIGHER EDUCATION RESPONSES TO COVID-19 IN KOREA AND TAIWAN

In response to the COVID-19 outbreak, Korea and Taiwan moved quickly to order their populations to stay at home, practice handwashing, engage in social distancing, and wear masks in public settings (22, 23). Given this situation resulting from the global pandemic, college students have experienced a "new normal" in the higher education environment. The International Association of Universities (IAU) survey report on the impact of COVID-19 on higher education institution (HEI) highlighted that one of the key challenges encountered by HEIs was the sudden shift to distance learning (24). The results of the report revealed that over 50% of HEIs across the globe made transitions from classroom teaching to distance learning. The rate of change varied by region, e.g., 85% in Europe, 72% in the Americas, and 60% in Asia. HEIs in different regions explored various formats for learning; some colleges and universities continued face-to-face learning, some explored blended or hybrid learning, and some went primarily online with some in-person courses or went fully online with no students on campus (25).

Colleges and universities in Korea and Taiwan took proactive actions, implementing different levels of restrictions to secure the safety of students. For example, college students in South Korea were temporarily restricted from campus facilities, and all courses switched to an online format in the spring of 2020. As remote learning became prevalent on campuses, the frequency of face-to-face interactions with peers and faculty decreased tremendously for Korean college students. Taiwan, on the other hand, was one of the few countries in which campuses remained in session, due to the virus appearing to be under control. In Taiwan, the government established guidelines to secure the safety of students and staff, while colleges and universities remained open during

the spring of 2020. Taiwanese students were required to wear a facemask, maintain social distancing in the classroom, and check their body temperature on a daily basis. The guidelines, including measures of self-management of health, quarantine, and regulations on school assemblies, also reduced opportunities for interacting with peers and faculty among Taiwanese college students (22).

As campus lockdown restricted opportunities for socialization and interaction among students and faculty on campus, college students' mental health became a special challenge during COVID-19 (26). Previous studies have pointed out that the campus environment is where socialization occurs, and also where students gain knowledge, integrate skills, and develop the capacity to cope with challenges in society (27). The new normal of non–face-to-face learning on campuses has limited college students' opportunities for physical interaction with peers and faculty. Thus, the pandemic had the unintended consequences of decreasing college students' opportunities to develop their capacities and resilience (28), causing an existential threat to their mental health. To better understand the ways that COVID-19 has impacted college students' lifestyles, the following research questions were asked:

Research Question 1: Have college students in South Korea and Taiwan presented different patterns of mental health during the COVID-19 pandemic?

Research Question 2: Have college students in South Korea and Taiwan presented different patterns of lifestyle change during the COVID-19 pandemic?

Research Question 3: How have students' lifestyle changes determined their mental health during the pandemic in South Korea and Taiwan?

PARTICIPANTS AND METHODS

Participants

Data were collected from college students in both South Korea and Taiwan between May and June of 2020. Participants were selected from two institutions, one in Seoul, South Korea and the other in Kaohsiung, Taiwan, each of which is a preeminent research university located in a big city. All college students in the Korean case were surveyed with convenience sampling using an e-mail invitation to an online survey that was sent to all students through the university's online system due to the campus lockdown and the enforced use of online learning platforms. In the Taiwanese case, participants were limited to college seniors and recruited using probability sampling and in-person interviews. International students were eliminated from the analysis. A total sample of 554 South Korean college students and 335 Taiwanese college students completed the survey. There were some similarities between the two institutions. For example, over 50 percent of participants were male in both South Korea (50.4%) and Taiwan (58.8%). In addition, most students were enrolled in STEM majors, including 53% of Korean students and 59% of Taiwanese students. There were also differences among the participants in the two selected countries; most of the Korean students' parents had received a bachelor's degree or higher (86%), while less than half (44%) of the Taiwanese students' parents had done so. More than half (52%) of the Taiwanese

respondents lived off campus, with another 40% in on-campus dorms and 8% at home. In the Korean sample, 56% reported living at home, 30% off campus, and 14% in an on-campus dorm.

Measures

Three aspects of mental health were assessed in the study, including "worry," "risk of contact," and "happiness." These three measures reflect key aspects of mental health, and have often been used in studies to determine mental health conditions during a pandemic (29–31). To measure the first indicator "worry," we asked students "*On a scale from 0 to 10, please rate how worried you are about COVID-19.*" The second variable, "risk of contact" was assessed using the question, "*On a scale from 0 to 10, please rate the possibility of contacting with a person known to have COVID-19.*" The third question measured happiness using a 4-point Likert scale that asked, "*How would you say things are these days—would you say that you are not at all happy, not too happy, fairly happy, or very happy?*" All three variables were treated as continuous in the analysis.

Seven measures of lifestyle change adapted from the existing literature were assessed to understand how COVID-19 changed students' lifestyles (30, 32). Students were asked, "*Compared to before the COVID-19 outbreak, how has your lifestyle changed?*" with regard to seven aspects of lifestyle, including traveling, spending time with friends, eating at restaurants, getting restaurant takeout, getting food delivered, having part-time jobs, and shopping online. The response options used a 5-point scale to allow the individual to express the change in frequency of each event. The scale responses were "decreased a lot," "decreased a little," "no change," "increased a little," or "increased a lot." All measures were treated as continuous variables indicating the frequency of lifestyle changes.

The questionnaire also collected data on sociodemographic characteristics, including gender, college major, parental education level, and living arrangements.

Statistical Analysis

To analyze the effects of lifestyle changes on students' mental health during COVID-19, we conducted the following three analyses. First, descriptive statistics of the key variables of the analytic sample were provided. Second, a *t*-test was used to examine whether the main items were significantly different between South Korea and Taiwan. Third, regression analyses were performed to examine the association between lifestyle changes and three aspects of mental health. All statistical regressions controlled for gender, parental educational level, college major, and living arrangement.

For the Taiwanese data, <1% of cases were missing, and listwise deletion was applied in the analysis. The Korean sample included no missing values. All analyses were conducted using Stata/MP16.1.

RESULTS

Mental Health During COVID-19

Table 1 presents descriptive statistics for all variables used in the study. The results showed that South Korean college students

TABLE 1 | Descriptive statistics.

Variable	South Korea		Taiwan		
	Mean	SD	Mean	SD	*t*
Dependent variables					
Worry	6.49	2.52	4.01	2.25	−15.17***
Risk of contact	5.60	2.36	3.05	2.02	−17.08***
Happiness	2.67	0.78	2.89	0.60	4.75***
Independent variables					
Life Change					
Travel	1.23	0.59	2.07	0.79	16.82***
Hangout with friends	1.69	0.71	2.79	0.54	25.90***
Eating at a restaurant	2.01	0.86	2.41	0.76	7.27***
Restaurant takeout	3.35	1.08	3.54	0.76	3.13**
Food delivery	3.85	1.06	3.41	0.72	−7.31***
Part-time jobs	2.13	1.05	2.99	0.54	16.01***
Online shopping	3.68	1.00	3.16	0.50	−10.42***
Major	%		%		
Liberal Arts	18.4%		17.6%		
STEM	52.5%		59.4%		
Business	4.5%		15.8%		
Social Sciences	24.6%		7.2%		
Gender					
Male	50.4%		58.8%		
Female	49.6%		41.2%		
Parental Education Level					
HS or less	7.9%		25.7%		
Some college	6.3%		30.2%		
BA	49.3%		20.3%		
Advanced	36.5%		23.9%		
Living Arrangement					
Home	56.0%		7.8%		
Dorm	14.3%		40.3%		
Outside the campus	29.8%		51.9%		
N	554		335		

*p < 0.05, **p < 0.01, ***p < 0.001.

were more worried about COVID-19 (*M* = 6.487; SD = 2.518) than Taiwanese college students were (*M* = 4.02; SD = 2.25). Additionally, the mean response for the possibility of having contact with someone with COVID-19 was 5.60 ± 2.36 in South Korea, but it was 3.05 ± 2.02 in Taiwan. Finally, the mean happiness score was 2.67 ± 0.78, compared to 2.89 ± 0.60 in Taiwan. The results from the *t*-test also indicated that South Korean college students presented a relatively higher level of mental health concerns than Taiwanese college students did.

To visualize differences in mean scores between the two selected countries with regard to the main outcome variables used in the study, **Figure 1** presents information for each item.

Lifestyle Changes During COVID-19

To investigate the different patterns of lifestyle changes, the survey questions inquired about college students' daily experiences during the COVID-19 lockdown. The two countries

FIGURE 1 | Comparison of mean scores for three aspects of mental health conditions.
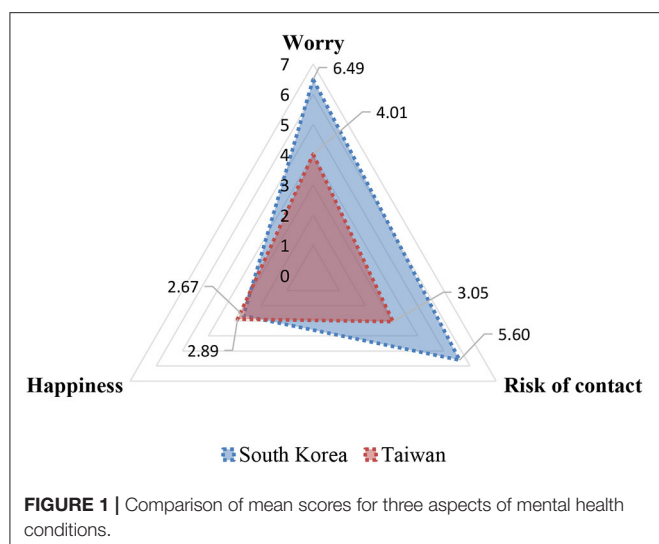
presented variations in their lifestyle changes resulting from the COVID-19 pandemic (see **Table 1**). Compared to Taiwanese students, South Korean college students significantly decreased their frequency of traveling (M = 1.23; SD = 0.59), spending time with friends (M = 1.69; SD = 0.71), eating at restaurants (M = 2.01; SD = 0.86), and working part-time (M = 2.13; SD = 1.05). Additionally, the results from the *t*-test indicated an increased frequency of food delivery (M = 3.85; SD = 1.06) and online shopping (M = 3.68; SD = 1.00) in South Korea compared to Taiwan (frequency of food delivery: M = 3.41; SD = 0.72; frequency of online shopping: M = 3.16; SD = 0.50).

Effects of Lifestyle Changes on Mental Health

To examine the relationship between lifestyle changes and three aspects of mental health, multiple regression analyses were conducted while controlling for gender, parental education level, living arrangement, and college major. For South Korea, age was also included as a control variable, since the data sample included undergraduates between 19 and 29. The age distribution of undergraduates ranged between 19 and 29 in the sample because in South Korea, the majority of college-aged male citizens are required to serve at least 21 months in the military, choosing whether they will suspend their undergraduate work during their years in college or take off immediately after graduation to serve in the army.

To assess the robustness of the findings, this study conducted a series of sensitivity analyses for Korean sample using senior college students only and also performed sets of analyses without controlling for age in each model. The overall results were similar to those based on primary analyses. The results of each model are reported in **Table 2**.

First, standard multiple regression analyses were performed to investigate the effects of lifestyle changes on worry during COVID-19 (see **Table 2**). The results show that among South Korean college students, an increasing frequency of spending

time with friends and working part-time was negatively correlated with being worried about COVID-19. In other words, when students had a higher level of worrying about COVID-19, they were more likely to decrease the time they spent with friends and engaged in part-time employment. Additionally, an increased frequency of online shopping was positively correlated with being worried about COVID-19. Students who were more worried about COVID-19 were more likely to go shopping online. Among Taiwanese college students, the pattern of part-time jobs was similar to that of South Korean college students, reflecting the negative relationship between part-time employment and being worried about COVID-19. The results of Taiwanese college students also presented a positive correlation between getting restaurant takeout and worrying about COVID-19. Students who were more worried about COVID-19 increased their frequency of getting restaurant takeout.

Second, we investigated the relationship between college students' lifestyle changes and their risk of contact with someone who has COVID-19, as demonstrated in **Table 2**. In Korea, the increasing frequency of spending time with friends and working part-time was negatively correlated with the self-reported risk of having contact with someone who has COVID-19. College students in Korea considered spending time with friends and working part-time to decrease the possibility of contracting COVID-19. However, Taiwanese college students presented different patterns. In Taiwan, the increasing frequency of online shopping was positively correlated with a self-reported risk of contact with someone who has COVID-19. Since the result indicated a relation and not causality, reverse causality existed between online shopping and the risk of contact with someone who has COVID-19. Taiwanese college students who reported a higher risk of contact with someone who has COVID-19 may go shopping online more often.

Third, the results predicting life changes and happiness indicated different patterns in both South Korea and Taiwan (see **Table 2**). In South Korea, the increasing frequency of spending time with friends and getting restaurant takeout was positively correlated with happiness, but food delivery was negatively correlated with happiness. During the COVID-19 pandemic, spending time with friends increased happiness among South Korean college students, reflecting the important role of social support from peers. The positive relationship between restaurant takeout and happiness also indicated the importance of having contact with other people during the COVID-19 pandemic in South Korea. In Taiwan, the increasing frequency of working part-time was positively correlated with happiness, reflecting that part-time employment increased levels of happiness as well as reflected the importance of interacting with other people during the COVID-19 pandemic.

Finally, statistically non-significant relationships between college students' lifestyles and mental health conditions were also presented in **Table 2**. The non-significant findings indicated the various role of life changes in predicting different aspects of mental health conditions in both South Korea and Taiwan. For example, both traveling and eating at restaurants were statistically non-significant with mental health conditions (i.e., worry, risk of contact, and happiness). Getting restaurant takeout

TABLE 2 | Results of multiple regression analyses on three aspects of mental health conditions.

Variable	Worry		Risk of contact		Happiness	
	Korea	Taiwan	Korea	Taiwan	Korea	Taiwan
Life change						
Travel	−0.215	−0.299	−0.039	−0.076	−0.096	0.037
	(0.185)	(0.170)	(0.182)	(0.157)	(0.061)	(0.048)
Hangout with friends	−0.625***	−0.198	−0.419*	0.282	0.138*	0.017
	(0.169)	(0.234)	(0.167)	(0.216)	(0.056)	(0.066)
Eating at a restaurant	−0.231	0.002	−0.182	0.243	−0.010	−0.076
	(0.131)	(0.189)	(0.129)	(0.174)	(0.043)	(0.054)
Restaurant takeout	−0.000	0.500**	0.019	0.161	0.102***	0.004
	(0.101)	(0.190)	(0.100)	(0.174)	(0.033)	(0.054)
Food delivery	0.070	−0.105	0.059	−0.157	−0.074*	−0.007
	(0.105)	(0.183)	(0.103)	(0.168)	(0.035)	(0.052)
Part-time jobs	−0.391***	−0.807***	−0.287**	−0.169	0.017	0.150*
	(0.103)	(0.224)	(0.102)	(0.206)	(0.034)	(0.063)
Online shopping	0.298**	0.335	0.124	0.716**	0.034	0.077
	(0.105)	(0.244)	(0.103)	(0.224)	(0.035)	(0.069)

Standard errors in parentheses. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.
All models include gender, age (Korea only), parental education level, living arrangement, and college major as control variables.

was statistically non-significant with the possibility of contracting COVID-19. The frequency of food delivery was statistically non-significant with both worry and risk of contact. The frequency of online shopping may not increase college students' happiness, since the relationship between online shopping and happiness was statistically non-significant.

DISCUSSION AND CONCLUSION

The purpose of the study was to examine the correlation between lifestyle changes and mental health among college students in South Korea and Taiwan during the COVID-19 pandemic. HEIs have been significantly disrupted, with millions of students around the world studying remotely due to campus closures (33). There is no clarity as to how COVID-19 will impact the overall operations of HEIs in upcoming semesters; however, what we clearly know is that this pandemic has produced some unexpected changes in the higher education community. In this regard, it is necessary to understand emerging patterns of lifestyle changes caused by the pandemic and college students' responses to their new experiences and mental health consequences of COVID-19. The main findings of the study are as follows.

First, we explored whether lifestyles changed among college students confronting a "new normal" in the two selected countries given the serious global health threat caused by the COVID-19 pandemic. College students in South Korea indicated a decrease in traveling, spending time with friends, eating at restaurants, and part-time employment, and an increase in food delivery and online shopping compared to college students in Taiwan. During the pandemic, Korean students significantly decreased their daily activities, as did many in other countries, while students in Taiwan experienced less lifestyle change (8). Second, we examined different patterns of mental health among students in the two countries. Similar

to findings from Bangladesh, China, and the U.S. (3, 8–10), college students in South Korea reported a higher level of worry, a higher possibility of having had contact with someone with COVID-19, and a lower level of happiness than before the pandemic. However, Taiwanese college students presented a different pattern, with a higher level of happiness than the South Korean students. A possible explanation could be that students in South Korea were temporarily restricted from campus facilities, while campuses remained open in Taiwan as the pandemic was under greater control there (22). Since campus lockdown restricted the opportunities for socialization and interaction on campus in South Korea (26), college students there may have struggled with mental health problems, feeling unsafe and anxious during COVID-19 (5, 6). The results from South Korea indicate that environmental changes such as those that occurred during the global pandemic can cause emotional and health issues even among non-infected individuals (2–5). Third, we discovered how different levels of lifestyle change have contributed to the mental health of college students in the two countries. The results indicated that social activities, including spending time with friends, were positively correlated with mental health in South Korea and Taiwan. The positive correlation between mental health and social activities in both South Korea and Taiwan confirmed the important role of the campus environment in developing students' capacity to cope with challenges in society (27). College students in South Korea who increased the frequency of time spent with friends were less worried about COVID-19, reported a lower possibility of having had contact with a person known to have COVID-19, and indicated a higher level of happiness. College students in Taiwan were less worried about COVID-19 if they increased the frequency of part-time employment.

In this study, we tried to investigate the unintended consequences of COVID-19 on college students' lives, assuming

that their experiences might vary based on how different institutions and countries have reacted to the pandemic. There were different patterns of policy and institutional responses to COVID-19 among HEI in South Korea and Taiwan (22–24). College students in Korea were required to stay at home, take online courses, or maintain social distancing during the pandemic, while students in Taiwan remained onsite with safety measures implemented on campus. Given the increase in confirmed COVID-19 cases and use of online teaching platforms in South Korea (11, 15), this may be the main factor explaining why Korean college students experienced more disruption of their daily routines and more mental health issues than Taiwanese college students. Finally, since both countries implemented a series of policy/program actions in response to the virus (15–17), college students in both South Korea and Taiwan decreased the frequency of daily activities and had fewer opportunities for socialization and interaction with peers and faculty under the new circumstances created by the COVID-19 crisis.

As the number of confirmed cases has continued to increase, governments and HEIs have taken more aggressive actions against the COVID-19 pandemic, including year-long campus lockdowns, temporary closures, and virtual learning formats (22). Campus lockdowns and online learning formats are aimed at reducing the possibility of physical contact during the pandemic; however, college students are receiving less emotional and social support from peers and colleagues who are self-isolating at the same time. This study highlights the positive relationship between social support and interaction with friends and mental health conditions. In line with previous studies that specified the importance of perceived social support in reducing mental health problems (34–36), our findings shed light on the importance of social and institutional support for college students in reducing the incidence and prevalence of some mental disorders during the pandemic, and suggest that more interventions and support from policy/program perspectives are needed.

The comparison between South Korea and Taiwan with respect to college students' mental health can benefit administration officials and policymakers as they implement policies and practices addressing the aftermath of the pandemic. Governments and HEIs across countries need more empirical evidence to balance safety and learning for college students.

We suggest that governments and HEIs organize social support activities through online or hybrid formats, since students' mental health is more vulnerable during COVID-19. Various social activities and forms of social support benefit the learning development and mental health among college students.

Along with these contributions, some limitations exist in our study. Considering the time constraints and data availability, the study was limited to two institutions from each of the selected countries. The results should be cautious while generalizing to the entire population in the selected countries. More research is needed in this unprecedented time to share insightful implications from various country contexts; empirical studies with nationally representative longitudinal datasets are also needed to support college students in maintaining their academic path in a safe manner.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

AUTHOR CONTRIBUTIONS

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Public Perception and Hand Hygiene Behavior During COVID-19 Pandemic in Indonesia

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Hand hygiene practices are important not only during the corona virus disease 2019 (COVID-19) pandemic, but also critical to prevent the possible spread of other infectious diseases. This study aims to examine the current hand hygiene behaviors during the COVID-19 pandemic, post pandemic behavior intentions, and the relationship between behavior, psychosocial and contextual factors. A cross-sectional online survey was conducted from 28 May to 12 June 2020, with 896 valid responses obtained from Indonesian citizens over 18 years old. The survey questions included demographic characteristics, individual practices, risk perceptions, attitude, norm factors and ability factors related to hand hygiene during the COVID-19 pandemic. Descriptive analysis, chi square and multiple logistic regression tests were used to analyse the data. The results showed that 82.32% of female respondents and 73.37% male respondents reported handwashing practice 8 times or more per day during COVID-19 pandemic. Participants who perceived themselves at higher risk of contracting SARS-CoV-2 (OR 7.08, 2.26–22.17), had less negative perception toward the practice (OR 1.93, 1.32–2.82), perceived handwashing as an effective preventive measure (OR 1.77, 1.23–2.54), were female (OR 1.71, 1.21–2.41), perceived a more supportive norm (OR 1.68, 1.15–2.44) and noticed more barriers in access to handwashing facilities (OR 1.57, 1.05–2.36) were more likely to engage in hand hygiene practice more frequently during the pandemic. In conclusion, the majority of respondents did increase their frequency of hand hygiene practices during COVID-19 pandemic. In line with previous studies in other pandemic contexts, sex, perceived susceptibility and effectiveness are important predictors of hand hygiene practices, which are similar to findings from previous studies in other pandemic contexts. Addressing social norm related to the perceived hand hygiene practices of friends and important people is a potential health promotion strategy by creating hand hygiene norms in the community.

Keywords: hand hygiene, COVID-19, psychosocial factors, behavior, online survey

INTRODUCTION

Corona virus disease 2019 (COVID-19) is a disease caused by severe acute respiratory syndrome coronavirus 2 (SARS CoV-2), a pathogen similar to SARS coronavirus that also causes respiratory disease (1). People with COVID-19 can suffer from mild infection to very severe disease. The SARS CoV-2 is carried in the nasopharynx, therefore spreading mainly through saliva droplets or nasal discharge when an infected person coughs or sneezes (2). The first cases of COVID-19 in Indonesia were announced by President Jokowi on March 2, 2020 in Jakarta. By 19th October, the Indonesian COVID-19 task Force reported 361,867 confirmed cases, 125,111 COVID-19 related deaths and 285,324 people recovered from COVID-19 (3). The Government of Indonesia has subsequently recommended a strategy to prevent transmission by performing the "three M's," which stand for: *memakai masker* (using a mask), *menjaga jarak* (maintaining physical distance of 1 to 1.5 m) and *mencuci tangan pakai sabun* (handwashing with soap).

Handwashing with soap (HWWS) has actually been suggested by the World Health Organization as the most effective and low-cost strategy to prevent SARS CoV-2 transmission (4). A recent study reported that hand hygiene together with other protective measures such as wearing mask and avoiding the crowd have also contributed to the decrease in other respiratory infections during COVID-19 pandemic (5). Moreover, a substantial amount of peer-reviewed literature has shown the benefits of hand hygiene to prevent many infectious diseases including gastrointestinal illnesses (6–10); trachoma and soil helminth infection (11, 12) as well as respiratory infection (6). Thus, hand hygiene practices are not only important during a pandemic, but also critical to prevent the spread of other diseases.

In order to better understand factors that promote hand hygiene practices as a public health measure, it is beneficial to examine the community's behaviors through behavioral change theories such as the *Health Belief Model* and *Theory of Planned behavior* (TPB) (13, 14). The *TPB* highlights the importance of someone having a strong desire to change (intention) prior to achieving a behavior change. A desire to change is influenced by several groups of factors, namely attitudes toward a behavior, subjective norms and perceived behavior control (15). Mosler (16) developed the Risk, Attitude, Norm, Ability and Self-Regulating (RANAS) model based on these theories design a behavior change program in the area of water, sanitation, and hygiene (WASH). The RANAS model posits that, there are five groups of psychosocial factors which may influence WASH related behavior change, i.e., perceptions of risk, attitude factors, norm factors, ability factors and self-regulation factors (16, 17). These elements are modifiable by contextual factors such as, social, physical and personal factors (17). In a health behavior study, perceived risk was measured by three dimensions i.e., a likelihood of harm, susceptibility to illness and severity (18, 19). Attitude factors include the perception of benefits and the negative impact of the behavior (17). Health behaviors are also strongly influenced by social norms, which describe other's perceptions on behavior, thus creating social pressure to perform

certain behavior (17, 20, 21). Ability and self-regulation factors represent an individual's confidence to perform and will to maintain the behavior (17).

Previous studies on preventive health behavior during the SARS-CoV epidemic and during the peak of the H1N1 epidemic have identified factors influencing the adoption of behavior which include: perceived likelihood for infection (22–24), perceived severity if contrating the disease and perceived effectiveness of the preventive behavior (23–25), and perceived ability to perform the behavior (24). Other contextual factors such as sex and age were also found to modify the preventive behavior (23, 25). However, many of these studies had limited attention to the negative perception toward the behavior and factors related to social norms that influence hand hygiene behavior among the general population. Other water, sanitation and hygiene (WASH) related studies have shown that this social norm is an important factor that can trigger and sustain behavior change (20, 26) and thus this factor should also be incorporated into post-pandemic WASH planning.

Although prevention measures introduced during the COVID-19 pandemic increased compliance with hand hygiene practices, it is important to understand how to sustain this practice in the post-pandemic period. Currently, the extent to which the COVID-19 pandemic has changed hand hygiene practices amongst the general population in Indonesia has not been systematically examined. Hence, this study is designed to explore three questions: the current situation and changes of hygiene behavior during the pandemic; behavior intention in the future of post-pandemic era; and the relationship between behavior and psychosocial factors (risk factor, attitude factors, norm factors and ability factors) as well as contextual factors. Understanding these factors is necessary to improve hand hygiene promotion or programming aiming for sustained behavior change for better prevention and management of possible disease outbreaks in the future.

METHODS

Respondents and Procedures

A cross-sectional online survey was conducted from 28 May to 12 June 2020 as an exploratory investigation of handwashing practices during the COVID-19 pandemic in Indonesia using a convenience sampling technique. The respondents were Indonesian citizens currently living in Indonesia and over 18 years old, recruited through announcements posted in social media platforms such as WhatsApp groups and Facebook.

An incentive of IDR 250,000 (US$ 15.7) was given to 20 randomly selected respondents by using a lucky draw to attract more response to the survey. The respondents who were willing to participate accessed an online survey platform via a link provided in the announcement and completed the self-administered survey. There were 896 valid responses from a total 951 responses obtained from the survey. Ethical clearance for the study was obtained from Ethics Committee of Faculty of Medicine, Udayana University, Number 1170/UN14.2.2.VII.14/LT/2020.

Instrument and Measurements

The questionnaire was developed based on the RANAS model on psychosocial factors relating to WASH behavior (16, 17) as well as previous studies related to hand hygiene behaviors and perceptions on health behavior (22–24). Subsequently, the questionnaire was piloted and revised based on trial feedback. Then, an online questionnaire was created using Google Form. All questions were set as required to be answered to prevent incomplete information and missing data. The five-part questionnaire included sections on demographic and information on settlement type; hand hygiene practices; psychosocial factors, including various perceptions toward hand hygiene; handwashing intention after the pandemic period; and sources of information related to health behavior to prevent COVID-19. A summary of the questions and the scale used for measurement is included in **Supplementary Table 1**.

Risk factors comprise of two variables: perceived susceptibility of being infected by SARS CoV-2 and perceived severity of if infected by SARS-CoV-2, where each was assessed with one question. Attitude factors consisted of two variables namely perceived effectiveness, which was measured with two questions on perceived effectiveness of hand hygiene preventing COVID-19 and other diseases, and negative attitude which was assessed with two questions on perceptions that handwashing is wasting water and wasting time. Perceived norm was assessed with three questions that included the perception of friends and other important people practicing more frequent hand hygiene, wearing a mask and maintaining social distance during COVID-19, perceptions of the need to be a good role model to others, and the perception that handwashing is part of religious norms. Ability factors consisted of perceived barriers which were assessed with questions on experience in accessing handwashing

facilities outside their homes or in public places. To improve construct validity, questions used for each variable were tested with Pearson validity test and Cronbach's Alpha reliability test (**Supplementary Table 2**).

Respondents were also asked on intention to maintain hygiene behavior post COVID-19 and their perception about risk when the COVID-19 pandemic is over. At the end of the questionnaire, respondents were asked about the media that were frequently accessed for information regarding hygiene practices. The data was handled with care and confidentiality was ensured by only allowing research staff to access raw data.

Data Handling and Analysis

Data analysis was conducted using Stata version 12.0 statistical software. Chi-squared tests were performed to assess the differences between variables related to handwashing practices and perceptions by sex and education level. Variables with $p \leq 0.05$ in Chi-squared test was considered tone significantly different. For education variables, we classified secondary education or below as low education and tertiary education as high education. We conducted a comparative analysis to seek confounding and effect modification. Chi-square tests and multiple logistic regression models were used to assess a potential correlation of demographic variables and perceptions variables with hand hygiene frequencies, in which variables with $p \leq 0.05$ are considered has a correlation. We re-classified categories of hand hygiene frequencies <8 times per day as low hygiene practice and frequencies of eight or more times per day as high hygiene practice. Variables of perceived effectiveness, negative attitude and perceived norm were re-categorized into two groups based on the median of the total score. This multiple logistic regression model was adjusted with socio-demographic

FIGURE 1 | Geographical distribution of respondents.
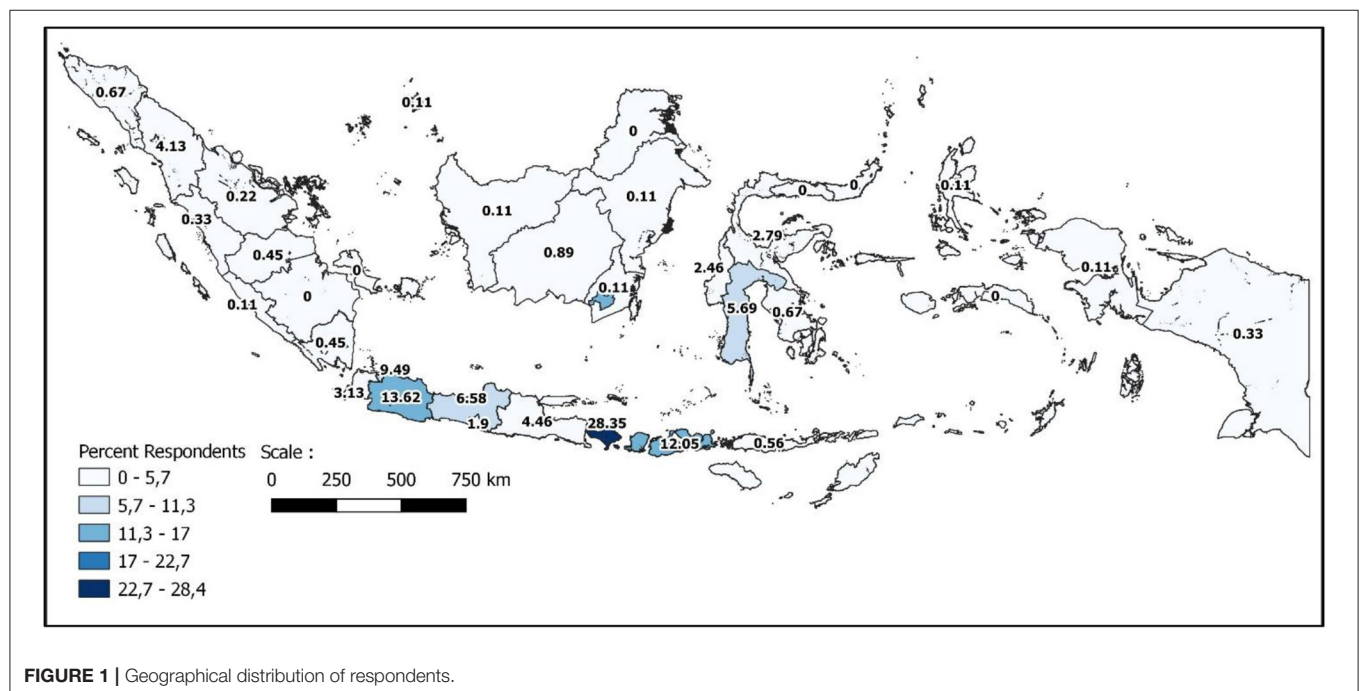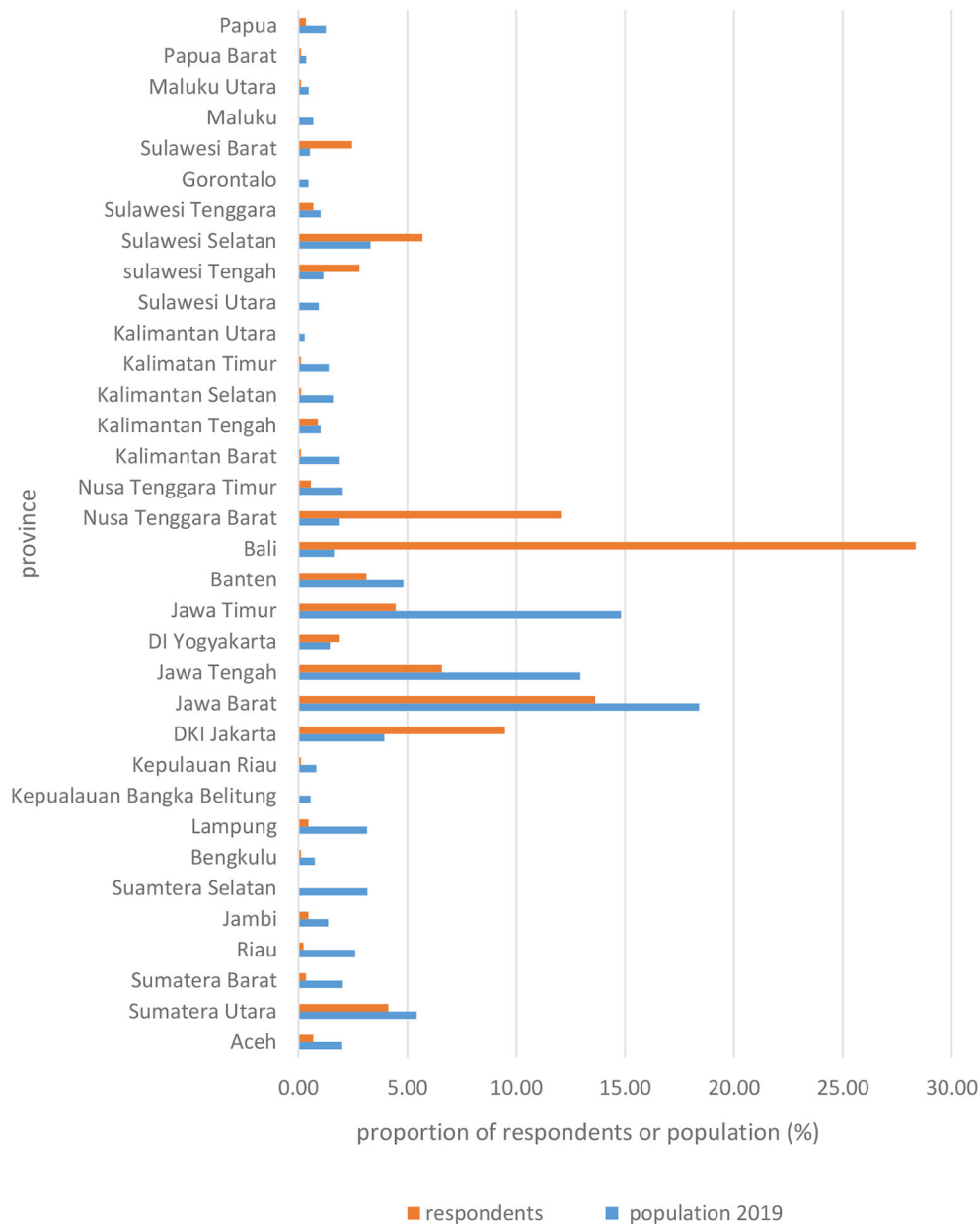
FIGURE 2 | Comparison between respondents and population distribution (bottom).

characteristics such as sex, education and age. Variables with $p \leq 0.05$ in multiple logistic regression were considered as independent predictors.

RESULTS

Demographic Characteristic

The 896 respondents who participated in this survey represented many provinces of Indonesia and mostly originated from provinces with mid- level category of COVID-19 cases. The geographical distribution of respondents in comparison with the population distribution is presented in **Figures 1**, **2**, showing that

the respondent's distribution is not in line with the population distribution due to the nature of convenient sampling. The majority of respondents were from Bali (254 respondents) followed by West Java (122 respondents) and West Nusa Tenggara (108 respondents). Participant characteristics are presented in **Table 1**. Most of the respondents were from urban areas, were female (60%) and the mean age was 35 years old. The background education of the respondents ranged from primary to university level, with the majority of respondents having a university education background (75.11%). Family income ranged from under IDR 1 million (US$ 68.25) up to more than IDR 10 million (US$ 682,5) per month, with the

majority of respondents earning from IDR 2.5 (US$ 170.61) up to IDR 5 million (US$ 341.23) per month (26.34%). Most of the respondents were employees in the private sector (36.61%) followed by students or unemployed persons (29.45%). The majority of respondents had a pipeline as their source of water (50.45 %), yet there was also a high percentage who sourced drinking water from a borehole (47.77%). While most of the respondents had never experienced water scarcity issues (67.08%), more than a quarter of respondents had experienced water scarcity for a few days, <10% of that over 2 days and <5% had experienced water scarcity over a couple of months in a year.

Handwashing Frequency

Female respondents reported higher handwashing frequencies than male respondents (p< 0.001) before and during the COVID-19 pandemic. There were 29.65 and 82.32% female respondents who reported handwashing frequencies of 8 times or more per day before and during the COVID-19 pandemic respectively, while there were 17.56 and 73.37% male respondents reporting handwashing practice with the same frequencies before and during the COVID-19 pandemic (**Table 2**). Female respondents also reported more handwashing frequencies before eating, when arriving home, after using the toilet, before preparing food, after working, after coming in contact with a sick person and after coughing or sneezing compared to male respondents during the COVID-19 pandemic ($p < 0.05$) (**Supplementary Table 3**). However, there was no significant difference between female and male respondents regarding handwashing practices before touching the face. Cleaning hands before touching the face and after coughing or sneezing were hand hygiene behaviors least frequently practiced (**Figure 3**). On the other hand, both female and male respondents (84.16 and 87.54% respectively) reported increased handwashing frequencies during the COVID-19 pandemic compared to pre-pandemic practices. Within each sex group, the increase in handwashing frequencies was statistically different between the time before and during the COVID-19 pandemic ($p < 0.001$) (**Figure 4**). There was also a difference in handwashing practices based on the education level of respondents. Respondents with a higher education level practiced handwashing more frequently than those with a lower education level ($p < 0.05$). Respondents with a higher education level also reported more frequent handwashing when arriving home ($p < 0.005$) and after using the toilet ($p < 0.05$) compared to those with a lower education level.

There were 95.4% of respondents who reported their intention to maintain their current handwashing frequencies when the COVID-19 pandemic ends, and there was no statistical difference between male and female respondents (**Table 2**). However, the intention was different between education level groups where respondents with high education level reported a stronger intention to maintain hand hygiene behavior after the COVID-19 pandemic ends compare to those with lower education level ($p < 0.01$). In regards to surface cleaning, there were 59.12 and 19.89% of female respondents who reported that they often and always practice surface cleaning at home during COVID-19, while 55.52 and 5.58% of male respondents reported the same practices ($p < 0.05$). These results indicate that sex and education

TABLE 1 | Socio-demographic characteristic of respondents.

Characteristics	n	%
Settlement type		
Rural	246	27.46
Urban	650	72.54
Sex		
Female	543	60.60
Male	353	39.40
Age		
Mean (SD)	35.57	11.51
<20	82	9.15
21–30	266	29.44
31–40	210	23.44
41–50	235	26.23
>50	103	11.5
Education		
Primary	1	0.11
Secondary	222	24.77
University	673	75.11
Family income		
<IDR 1million US$ 68.25	144	16.07
IDR 1–2.5 million (US$ 68.25 - 170.61)	144	16.07
>IDR 2.5–5 million (US$ 170.61–341.23)	236	26.34
>IDR 5–10 million (US$ 341.23–682.5)	220	24.55
>IDR 10 million (US$ 682.5)	152	16.96
Occupation		
Entrepreneur	83	9.26
Employee	328	36.61
Teacher	15	1.67
Health workers	12	1.34
Government employee	195	21.76
Students/unemployed	263	29.35
Drinking water sources		
River, spring, rainwater	8	0.89
Drinking water vendor	8	0.89
Borehole	428	47.77
Pipeline	452	50.45
Water scarcity issue		
Never	601	67.08
A couple of days/year	196	21.88
A couple of weeks/year	59	6.58
A couple of months/year	40	4.46
Provincial-level of COVID-19 cases		
Low (<1%)	90	10.04
Medium (1-5%)	449	50.11
High (<5%)	357	39.84

level have modification effect on the handwashing frequencies of the respondents as well as intention to maintain the practice in post-pandemic era.

Variables	Male		Female		Total		*p*-value
	n	%	*n*	%	*n*	%	
Hand hygiene frequencies before COVID-19							0.000
<4 times/d	143	40.51	131	24.13	274	30.58	
4–<8 times/d	148	41.93	251	46.22	399	44.53	
8–<12 times/d	53	15.01	129	23.76	182	20.31	
>12 times/d	9	2.55	32	5.89	41	4.58	
Hand hygiene frequencies during COVID-19							0.005
<4 times/d	12	3.4	6	1.1	18	2.01	
4–<8 times/d	82	23.23	90	16.57	172	19.2	
8–<12 times/d	130	36.83	216	39.78	346	38.62	
>12 times/d	129	36.54	231	42.54	360	40.18	
Reporting increase HH frequencies							0.161
Yes	309	87.54	457	84.16	766	85.49	
No	44	12.46	86	15.84	130	14.51	
Cleaning surface before COVID-19							0.000
Never	20	5.67	11	2.03	31	3.46	
Rare	127	35.98	150	27.62	277	30.92	
Sometimes	144	40.79	245	45.12	389	43.42	
Often	51	14.45	120	22.1	171	19.08	
Always	11	3.12	17	3.13	28	19.08	
Cleaning surface during COVID-19							0.006
Never	5	1.42	0	0	5	0.56	
Rare	17	4.82	18	3.31	35	3.91	
Sometimes	80	22.66	96	17.68	176	19.64	
Often	196	55.52	321	59.12	517	57.7	
Always	55	5.58	108	19.89	163	18.19	
Intention to keep hygiene behavior post COVID							0.264
Low	20	5.7	22	4.1	42	4.7	
High	333	94.3	521	95.9	854	95.3	

Total responses = 896; Significance of independence of samples indicated by Pearson Chi-Square test: p-value < 0.05.

Perceptions Related to Handwashing Behavior and Information Sources

In this study, 66.9% of respondents perceived that they have a medium to low risk of contracting COVID-19, and 65% of respondents perceived that they would only have mild to no symptom if they contracted COVID-19 (**Table 3**). On the other hand, many respondents perceived handwashing as an effective measure to prevent COVID-19 and other diseases (61.3%), and had less negative perceptions toward handwashing practice (77%). Regarding social norms, similar composition of respondents reported non-supportive perceived norms (52%) and supportive perceived norms (48%). When asked about barriers in accessing handwashing facilities, the majority (72.9%) reported less frequent barriers. Female and male respondents were only different regarding their perception toward susceptibility ($p < 0.05$) but were not different for other types of perceptions. In summary, even though many respondents perceived that they have low risk of COVID-19, they believe that hand washing is an effective measure for

disease prevention and that their networks were supportive of the behavior.

Factors Associated With the Frequency of Handwashing

In the multiple logistic regression, women were more likely to report a higher frequency of handwashing practice during the COVID-19 pandemic compared to men (OR 1.71, 95% CI 1.21–2.41) (**Table 4**). Respondents who perceived that they were susceptible to contracting COVID-19 disease were more like to wash their hand frequently (OR 7.08, 95% CI 2.26–22.17), as did respondents who perceived that handwashing is an effective measure to prevent diseases were more likely to practice frequent handwashing (OR 1.77, 95% CI 1.23–2.54). Moreover, respondents who had less negative attitude toward handwashing practice (handwashing is wasting water and time) reported more frequent handwashing compared to those with more negative perception (OR 1.93, 95% CI 1.32–2.82). Perceived norms were also found to be influential on handwashing frequency. Respondents who perceived more positive norms

TABLE 3 | Respondents' perceptions toward hand washing behavior as preventive measure to contract COVID-19.

Variables	Male		Female		Total		*p*-value
	n	%	*n*	%	*n*	%	
Perceived susceptibility							0.047
Very low risk	36	10.2	45	8.3	81	9.0	
Low risk	69	19.5	130	23.9	199	22.2	
Medium risk	117	33.1	202	37.2	319	35.6	
High risk	104	29.5	117	21.5	221	24.7	
Very high risk	27	7.6	49	9.0	76	8.5	
Perceived severity							0.660
No symptom	70	19.8	123	22.7	193	21.5	
Mild symptom	151	42.8	238	43.8	389	43.4	
Symptom that can affect daily activities	103	29.2	141	26.0	244	27.2	
Severe consequences	19	5.4	23	4.2	42	4.7	
Fatality	10	2.8	18	3.3	28	3.1	
Perceived effectiveness							0.306
Not effective	144	40.8	203	37.4	347	38.7	
Effective	209	59.2	340	62.6	549	61.3	
Negative attitude							0.644
More negative attitude	84	23.8	122	22.5	206	23.0	
Less negative attitude	269	76.2	421	77.5	690	77.0	
Perceived norm							0.250
Less positive norm	192	54.4	274	50.5	466	52.0	
More positive norm	161	45.6	269	49.5	430	48.0	
Perceived barriers							0.512
Frequent encounter barriers	100	28.3	143	26.3	243	27.1	
Rarely encounter barriers	253	71.7	400	73.7	653	72.9	

Total responses = 896; Significance of independence of samples indicated by Pearson Chi-Square test : p-value < 0.05.

FIGURE 3 | Respondents reporting hand hygiene practice at particular time with five different categories of frequencies.
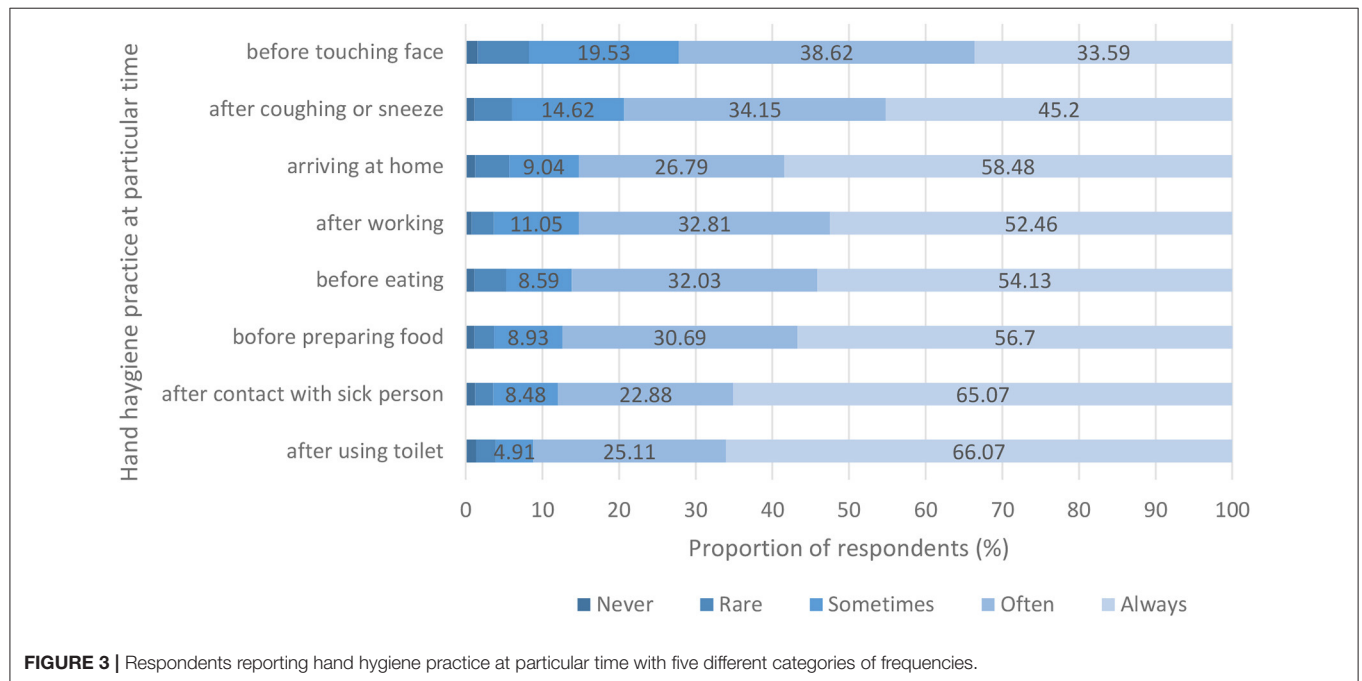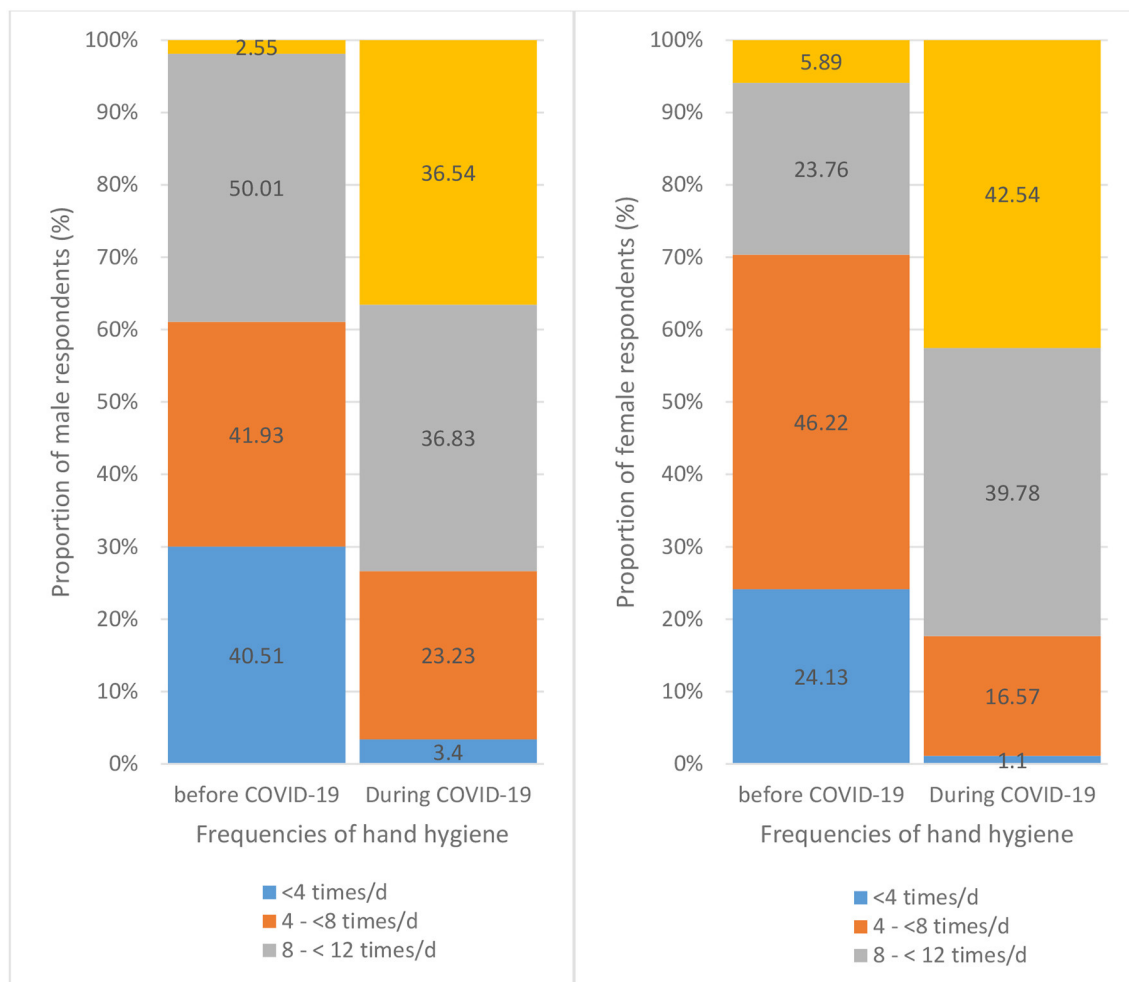
FIGURE 4 | Change in hygiene frequencies from before to during COVID-19 pandemic for male group (left) and female group (right).

in their surrounding environment, where their friends and important people were also frequently practicing COVID-19 prevention behavior, where they felt it was necessary to provide good examples to others, and the perception that hand hygiene is a part of religious values, were more likely to frequently wash their hands (OR 1.68, 1.15–2.44). Interestingly, respondents who reported more experience with access or barriers to handwashing facilities were also more likely to wash their hand more frequently (OR 1.57, 95% CI 1.05–2.36) (**Table 4**). The findings show that in addition to sex, many psychosocial factors also have significant influence on the respondents' handwashing frequencies during the pandemic. On the other hand, education, age and perceived severity did not show significant association with the same practice.

DISCUSSION

This study examines the frequency of hand hygiene practices before and during the COVID-19 pandemic in Indonesia 10 weeks following the first announcement of social restrictions in

Bali, and analyses the psychosocial factors affecting behaviors. The instrument used to measure hand hygiene behavior and relevant perceptions was deemed to have good validity and reliability according to Pearson validity test and Cronbach's Alpha reliability test. The results indicate that there is a significant increase in daily handwashing frequency during the COVID-19 pandemic reported by a majority of respondents. A study in United States (US) also found that respondents report handwashing practice more frequently than usual during the COVID-19 pandemic (27). Likewise, similar trends were found in daily handwashing frequencies during HINI influenza pandemic in Hong Kong, where 30.3% university students report increased hand hygiene frequency (23). Furthermore, the adoption of personal protective measures during the SARS pandemic in Hong Kong also increased considerably, however the practice decreased in the post-pandemic period (22). In our study, most respondents reported their intention to maintain their current hand hygiene practices when the pandemic ends. However, respondents with a lower education level reported less intention compared to those with higher education level. This indicates that a continuous

TABLE 4 | Factors influencing more frequent Hand Hygiene Practice (8 or more times per day) during COVID-19 pandemic.

Variables	Univariate			Multivariate		
	OR	95% CI		OR	95% CI	
Sex						
Male	1			1		
Female	1.69	1.22	2.33	1.71	1.21	2.41*
Age						
<20	1			1		
21–30	1.33	0.77	2.32	1.17	0.61	2.25
31–40	2.07	1.14	3.76	1.60	0.78	3.29
41–50	1.90	1.06	3.40	1.54	0.75	3.17
>50	1.23	0.64	2.35	1.08	0.49	2.41
Education						
Up to high school	1			1		
University	1.35	0.94	1.93	1.08	0.68	1.70
Perceived Susceptibility						
Very low risk	1			1		
Low risk	1.23	0.70	2.17	1.66	0.89	3.11
Mild risk	1.68	0.98	2.89	2.18	1.19	4.00*
High risk	2.02	1.13	3.62	2.21	1.15	4.25*
Very high risk	6.34	2.28	17.62	7.08	2.26	22.17*
Perceived severity						
No Symptom	1			1		
Mild symptom	0.76	0.50	1.17	0.78	0.49	1.25
Symptom that limit daily life	0.87	0.54	1.40	0.70	0.41	1.20
Severe symptom	0.98	0.42	2.28	0.70	0.29	1.74
Fatal (death)	1.06	0.38	2.96	0.38	0.12	1.25
Perceived effectiveness						
Not effective or not sure	1			1		
Effective	2.30	1.67	3.19	1.77	1.23	2.54*
Negative attitude						
More negative	1			1		
Less negative	2.37	1.67	3.36	1.93	1.32	2.82*
Perceived norm						
Less supportive norm	1			1		
More supportive norm	2.18	1.56	3.05	1.68	1.15	2.44*
Perceived barriers						
Frequent encounter barrier	1.30	0.90	1.90	1.57	1.05	2.36*
Rarely encounter barrier	1			1		

*Statistics indicate significance of OR with p-value < 0.05. The p-value of Hosmer–Lameshow test was 0.705 and the classification table shows that model provide 79% correct prediction.

promotion on hand hygiene after the pandemic is necessary to prevent future spread of diseases, targeting the population with lower education levels.

Consistent with previous studies, the results showed that there was a significant difference between sex in regards to daily hand hygiene practices during pandemic situations, where female respondents tend to report higher handwashing frequency per day compared to male respondents (23, 25, 27, 28). In our study, female respondents reported more hand hygiene practice at almost all critical points than male respondents except handwashing before touching the face. A previous study reported that university students were observed to touch their face 23

times per hour, suggesting a high frequency of face touching that involved contact with mucous membrane (such as the mouth, the nose and the eyes) that will increase the risk of infection, therefore hand hygiene compliance is a really important measure to prevent disease transmission (29). Our study also indicates that the difference in daily handwashing frequencies between male and female respondents is also consistent with findings before the pandemic situation. Thus, future hygiene promotion and disease prevention information should consider targeting males to improve the practice among this population group.

Regarding the perceptions relating to hand hygiene, this study shows that more than half of the respondents perceived that they

are not susceptible to COVID-19 (no risk to medium risk) and perceived contracting only mild symptoms if infected. Similarly, a previous study during another pandemic also indicated that only a small percentage of respondents (7.7%) perceived a high or very high risk of being infected by the disease, and slightly fewer respondents (56.1%) compared to the proportion in our study perceived the possibility of having only mild symptoms from the disease (23). However, another study during early COVID-19 pandemic in US considered that respondents perceived that they have relatively high risk of being infected with a mean score of 43.6 ± 26.62 out of 100 (27).This perception also increased over time during the study period (27). Another study showed a higher risk perceived by Norwegian respondents where they were 60% likely being infected (28). These differences might results from varying health information and promotion exposures in the context of different countries, side from the effects from other demographic characteristic. Changes in perceptions can also occur over time depending on the fluctuation in pandemic situation in the country.

Many respondents in this study (61.3%) perceived that handwashing with soap is an effective prevention measure for COVID19 and other diseases. Previous studies reported that a higher percentage of respondents (93.3%) from the general population perceived frequent handwashing as an effective SARS prevention measure (25) and 95.7% of respondents from university students perceived that handwashing can prevent H1N1 influenza (23). The results of this study found that females are perceived themselves to be more susceptible of contracting the disease than male respondents, but both sexes did not show significant differences in regards to other perceptions. Park et al. (23) similarly found this difference in their study, but they also found that females and males had different perceptions toward severity if being infected and males are more likely than females to perceive handwashing with soap as effective. This difference could have resulted from differences in the respondents' characteristics and country context. As perception toward disease risk and effectiveness of behavior might vary over time and in different places during the pandemic, promotion messages need to be carefully designed to maintain the perception on the importance of hand hygiene in preventing diseases not only during, but also after the pandemic.

In this study, female respondents, respondents who perceived that they were more likely to be infected by COVID-19, respondents who perceived that handwashing with soap or with hand-sanitiser was an effective way to prevent COVID-19 transmission were more likely to frequently wash their hands during the COVID-19 pandemic. These findings are consistent with other studies stating that that sex (23), perceived susceptibility (24) and perceived effectiveness (23, 28) are predictors of preventive health behaviors. This study adds that the other types of perception related to negative attitudes toward behavior and perceived norm were significantly affecting handwashing frequency of the respondents during the pandemic situation. In this study, the perception that frequent handwashing can waste clean water and time, significantly predicts less frequent hygiene practice. Physical barriers such as water availability is one of the common barriers for handwashing

practice, especially when water is limited (20) and thus may create this negative perception toward frequent handwashing practice. Social norms that are supportive toward the adoption of frequent handwashing practice and other preventive behavior were also found to influence practice, particularly the perception that their close friends and other important people were practicing the behavior more frequently during the COVID-19 pandemic. This has also been discussed in another study during the COVID-19 pandemic, that a group's behaviors and attitudes might explain increase in health protective behaviors (28). A previous study which was conducted in a non-pandemic situation indicated that social norms concerning the acceptance of hygiene water handling at home by all family members is a significant predictor to hygiene practice (30). Studies on the adoption of sanitation behaviors also highlight that social norms, such as where the perception that people in surrounding environments use toilets for defecating, can influence the adoption of similar behavior (31, 32). The social norms created after sanitation intervention related to unacceptance of open defecation has also improved community hygiene behavior (26). This finding highlights the importance to create a social norm, for example through community action as a potential promotion strategy to support the adoption of more hygienic practices in the community and in particular target groups.

Interestingly, perceived barriers in accessing handwashing facilities was more likely reported by respondents who reported more frequent handwashing practice. This could possibly be explained by the fact that respondents who frequently practice hand hygiene will be more concerned and more observant in searching for hand-washing facilities. Thus, they are more likely to notice this barrier compared to those who practice less frequent handwashing. Reducing this barrier and encouraging more people to wash their hands can be done through a small environmental modification known as nudging (21, 33). For example, since the COVID-19 pandemic, it was suggested to business and building managers to allocate hand-washing stations at the entrance of buildings in order to prompt good practice by visitors.

Limitations of the Study

This study is limited in several ways. Firstly, a sampling bias may occur due to the way the survey was announced and distributed via social media. This distribution will highly depend on the social networks of the researcher which can caused an uneven geographical distribution of the respondents in this study. The survey also had limitations in that it was more likely to obtain responses from respondents who interested in the topic of hygiene, even though rewards were offered to reduce this selection bias. Moreover, respondents who did not have internet access and with primary education level or lower were uncaptured in the survey, thus the study result should be interpreted as limited to respondents without this characteristics. Compared to another study in Aceh, Indonesia, where the proportion of respondents with primary education level was 27% (34), while this study only captured 0.1% of this group. A follow-up study using a randomized recruitment design is planned to obtain a more representative sample.

Another limitation is related to the self-reporting nature of the survey, which might result in higher frequency of handwashing behavior reported by the respondents than the actual practice. For a comparison, a systematic literature review estimated that there were only 17% (95% CI 7–36%) of the population in South-East Asian countries who practiced handwashing with soap under non-pandemic conditions (35), while in this study, daily handwashing for eight or more times a day was reported by 17.56 % (male) and 29.65% (females) respondents before the pandemic. Measurement with Likert-scale was used in order to better capture variations in the behavioral outcomes and perceptions of respondents.

Despite the limitations, this study provides insights into the perception and hygiene behavior of the general population during the COVID-19 pandemic. In a pandemic situation, the communication of risk and promotion of preventive measures of COVID-19 transmission have been able to increase hygiene practices of the Indonesian population. This study also confirms the psychosocial factors that affect hand hygiene practices identified in other studies. Moreover, this study also adds that social norm is an important factor to encourage better compliance with handwashing practices. Thus, promotion strategies can be targeted to create this supportive norm to increase adoption and sustainability. Although understanding these psychosocial factors is important to design effective hygiene promotion strategies, other factors in the socio-ecological model of health are also crucial to be addressed to complement promotion strategies. As mentioned in the five action strategies of the Ottawa Charter, creating a supportive environment such as ensuring equity of water access and other supporting infrastructure as well as developing institutional and policy support to address social structural issues are necessary measures to more comprehensively address the issues of hygiene practice (36).

CONCLUSION

In conclusion, the majority of respondents did increase their frequency of hand hygiene and reported handwashing of eight or more times each day during the ongoing COVID-19 pandemic. Sex, perceived susceptibility and effectiveness are important predictors of hand hygiene, which are similar to findings from previous studies in other pandemic contexts. This research highlights the importance of addressing the social norms that related to the perceived practice among friends and important people as a potential promotion strategy targeting specific groups by creating hand hygiene norms in the community.

The findings also suggest the importance of eliminating barriers to access water and handwashing facilities to facilitate hygiene practices. Considering these factors that affect hygiene behavior is not only important to improve health promotion strategies during the pandemic, but also to improve promotion to sustain hand hygiene behavior after the pandemic as basic prevention measures, which is still crucial in developing countries.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Ethics Committee of Faculty of Medicine, Udayana University. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpubh.2021.621800/full#supplementary-material

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Knowledge, Attitude, and Self-Reported Practice Towards Measures for Prevention of the Spread of COVID-19 Among Australians: A Nationwide Online Longitudinal Representative Survey

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Objective: To assess and share learnings on the motivators and behavioural adherence across sex and age to evolving strategies in public policy to prevent the spread of SARS-CoV-2 at the end of a first COVID-19 wave and the beginning of a second COVID-19 wave in Australia.

Design and Setting: A national longitudinal survey using a framework based on evidence-based behaviour change models. The survey was administered to a national sample representative across sex, age and location was undertaken at two time points: May 1st to 5th, 2020, and July 1st to 7th, 2020.

Results: Overall 2,056 surveys were completed across the first and second rounds, with 63% (1,296/2,056) completing both. Age range was 18–99 years (median 53, IQR: 34–64). Suboptimal physical distancing and self-quarantining if unwell/diagnosed was reported in one in four respondents and not getting a test at onset of symptoms reported in one in three. Those non-adherent to all three behaviours (19%, 60/323), were mainly male, younger, lived in major cities and reported fewer concerns or motivators to change behaviour. Overall, government lockdown measures were considered very important by 81% (835/1,032) and appropriate by 75% (772/1,029).

Conclusions: Prior to the suppression of a second COVID-19 wave, a significant minority of Australians reported suboptimal behavioural adherence to vital policy strategies to limit SARS-CoV-2 spread, mostly young adults and men. Successful wave 2 suppression required consistent communication from political and health leaders and supportive public health and economic strategies. Additional lockdown and punitive

strategies were needed in Victoria and were generally well-supported and adhered to. To limit subsequent lockdown, this work reinforces the need for a mix of communication around saving lives of the vulnerable, and other strategies targeting high risk groups, facilitation of easy testing and minimisation of financial impacts.

WHAT IS ALREADY KNOWN?

- Governments globally have been forced to implement extraordinary public health measures to control the spread of disease and prevent significant loss of life, and these interventions require substantial and sustained behaviour change, and come at significant personal, psychosocial and economic costs.
- If we are to be successful in containing SARS-CoV-2, we must utilise evidence from behavioural sciences in order to optimise policy adherence and create an environment which enables and motivates that behaviour.
- The second COVID-19 wave in Australia has been controlled. Daily cases at end of July were: 723 in Australia, 846 in United Kingdom, and 1,377 in France. Mid-October it was 11 in Australia, 16,171 in UK and 25,068 in France. Australian's public health response succeeded by having the right balance of government support and regulation—including a very strict and well-tolerated regional stage-4 lockdown.

WHAT ARE THE NEW FINDINGS?

- We have self-reported Australian behaviours, knowledge, motivations, and concerns around COVID-19 at two important time points; after the first COVID-19 wave and at the beginning of a second COVID-19 wave.
- Strategies to support behavioural adherence with policies to limit SARS-CoV-2 spread included daily joint communication from political and public health leaders, supportive economic measures (e.g., financial income support schemes) and public health strategies (e.g., free universally accessible testing and healthcare).
- Most Australians were adherent but a small majority, mainly men and young adults, did not adequately socially distance, quarantine or test if unwell. In a geographically isolated second COVID-19 wave, additional strict lockdown and punitive measures were generally supported, adhered to and were successful.

WHAT DO THE NEW FINDINGS IMPLY?

- Australia has now successfully reduced COVID-19 cases from two waves of significant SARS-CoV-2 transmission, and the world might benefit from the strategies applied.
- Behavioural research has a key role to play in assisting government and informing the public on evidence based strategies in the fight against COVID-19 moving forward.

STRENGTHS AND LIMITATIONS

- This research captured a large, representative sample of the adult Australian population across age, sex, location, and socioeconomic status.
- We have self-reported Australian behaviours, knowledge, adherence to health measures, types of concerns, and adherence motivators around COVID-19 at two important time points; after the first wave and at the beginning of a second wave, which was then successfully controlled and lessons are applicable globally.
- The survey is based on established behavioural theories, and is the Australian arm of the international iCARE survey which to date has collected global comparative information from over 90,000 respondents in 140 countries.
- Our survey was only available in English, which may have led to an underrepresentation of ethnic groups, and participation was voluntary, so our sample may be prone to selection bias from those with more interest or engagement in COVID-19.
- We also rely on self-reported behaviour, which may have led to socially desirable traits being over reported.

INTRODUCTION

The COVID-19 pandemic has had an unprecedented impact of the lives of people around the world (1). Australia has had experience with two waves of COVID-19 and reducing COVID-19 cases successfully twice (2). Without effective treatment or a vaccine, governments globally have been forced to implement extraordinary public health measures to control the spread of disease and prevent significant loss of life. These interventions require substantial and sustained behaviour change, and come at significant personal, psychosocial and economic costs (1). If we are to be successful in containing SARS-CoV-2, we must utilise evidence from behavioural sciences in order to optimise policy adherence (3), and create an environment which enables and motivates that behaviour (4).

Health behaviour models such as the "capability," "opportunity," "motivation," and "behaviour" model COM-B and the Health Beliefs Model highlight important factors influencing behaviour (3, 5–7). Examples of these factors include: perceiving a personal threat; believing a behaviour is effective to avoid that threat; possessing the capability to enact the behaviour; and having an environment which enables that behaviour. These factors may vary greatly across demographic subgroups, leading to differing patterns of behaviour (8).

However, we currently have limited empirical data for use in the application of these models to COVID-19.

This study aims to understand the drivers of behaviour around COVID-19, in order to better inform public health policies. To do this we analysed two rounds of representative data (2 months apart: early May and early July 2020) consisting of self-reported behaviours, knowledge, motivations and concerns around COVID-19 by Australians. The first survey round was 1 month after the first wave peak when Australia had successfully reduced daily cases from a peak at 469 to 14 (2). The second survey round was at the start of wave 2 when daily cases had increased to 86 (and later reached a peak at 701 ∼1 month later, mostly in the state of Victoria, before being successfully reduced) (2). **Supplementary Table 1** shows the public health policies implemented in Australia around these times. Although the second COVID-19 wave was predominantly localised within Victoria, at the time of the second survey all other Australian states and territories were on high alert anticipating the potential rise in local cases.

This paper focuses on three key behavioural interventions designed to limit the spread, including: physical distancing; getting tested when symptoms develop; and self-quarantining. We also examine the demographics, concerns and motivators of subgroups, which are defined by varying levels of policy adherence. In doing so we aim to provide insights into policy strategies that will equip the public with the opportunity, motivation and capability (5) to adhere to key behaviours needed to control COVID-19.

METHODS

Recruitment for this longitudinal Australian survey occurred in two rounds: a first survey round, May 1st to 5th, 2020, and a second survey round, July 1st to 7th, 2020. Representative national sampling using an online survey based on evidence-based behaviour change models was conducted. Representative sampling for key demographics of the Australian population was done by sex, age, and residential location (see further below for more detail).

This project is the Australian arm of the international iCARE (International COVID-19 Awareness and Responses Evaluation) study looking at people's understanding, attitudes, beliefs and actions towards COVID-19 (coronavirus/novel coronavirus) which has to date collected over 70,000 surveys from 140 countries (8). The iCARE study is a multi-round cross-sectional observational study of people's awareness, attitudes, and responses to the COVID-19 pandemic that is tagged to national policy and case data. The study is led by the Montreal Behavioural Medicine Centre (MBMC: www.mbmc-cmcm.ca) in collaboration with a team of international collaborators. It has received REB approval from the Comité d'éthique de la recherche du CIUSSS-NIM (Centre intégré de santé et de services sociaux du Nord-de-l'île-de-Montréal), approval #: 2020-2099 / 25-03-2020. The international survey recruitment began on March 27th, 2020 (8). The Australian version of the survey is identical to the international version with the addition

of four extra questions relevant to the Australian context. The project below was considered by the Monash University Human Research Ethics Committee and the committee was satisfied that the proposal meets the requirements of the National Statement on Ethical Conduct in Human Research and has granted approval (MUHREC Project ID: 24449).

Patient and Public Involvement

As part of the main iCARE study, there are a number of community collaborators who provided input into the development of the survey design, ensuring that the items are relevant and appropriately worded, this is particularly critical when developing a survey that has to be distributed across multiple countries around the globe. To ensure the survey was applicable and relevant to the Australian population, the international iCARE survey was reviewed by the Monash Partners Consumer and Carer group prior to the first round. This involved two members paid for their time to identify text that wasn't clear or irrelevant to Australia, and recommend alternative wording and areas to clarify. Other community members and contacts of the researchers provided input into the timing to complete the survey, and subsequently this feedback resulted in the survey being shortened to reduce participant burden.

Participants and Sampling Strategy

The first survey round with two reminders recruited 1,005 people. The 2nd survey round, along with and two reminders when needed, was sent to these 1,005 participants, yielding 648 repeat responses. New participants were then invited in another two rounds, ensuring representativeness was maintained, with an end total of 1,051 round two survey respondents.

This sample was captured by contracting an external cross-panel market research provider to send invitations to complete the online survey to ∼12,000 people, using a well-established database and reimbursement in accordance with ISO 26362 and industry requirements. Reimbursement was delivered by post to a physical address, enhancing validation of respondents and avoiding limitations of other panels that reward *via* electronic means (increased numbers of professional respondents, duplication within the panel and panellists that reside outside of Australia). Participants aged 18 years and over, who resided in Australia were invited to complete the online study *via* targeted emails describing the content and estimated duration of survey. Participants were consented online, after reading the study purpose. To ensure broad representativeness, demographics of the targeted sample were aligned with the Australian Bureau of Statistics (ABS) population characteristics (9). A representative sample is a subset of a larger group and represents the same properties and proportion of a larger population. Whilst this cannot be representative across all population characteristics, it is a widely accepted approach (10) and we aimed for this sample to be consistent with the population proportions across sex, age, and residential location (state/territory and remoteness area) (**Table 1**). After 4 days of recruitment, age, sex, and broad location of residence (state/rurality) of participants were examined, and further

TABLE 1 | Demographics of the participants who completed a round 1 survey (*n* = 1,005) and round 2 survey (*n* = 1,051) in Australia.

	Australian population	Round 1		Round 2		Total	
	(%)	*n*	(%)	*n*	(%)	*n*	(%)
Total surveys	-	1,005	(100)	1,051	(100)	2,056	(100)
Sex[s]							
Male	50	498	(49.6)	537	(51.1)	1,035	(50.3)
Female	50	499	(49.7)	507	(48.2)	1,006	(48.9)
Other	0	4	(0.4)	4	(0.4)	8	(0.4)
Missing	-	4	(0.4)	3	(0.2)	7	(0.3)
Age[s]							
18–29	22	90	(9.0)	266	(25.3)	356	(17.3)
30–39	18	192	(19.2)	168	(16.0)	360	(17.5)
40–49	16	161	(16.1)	154	(14.7)	315	(15.3)
50–59	16	202	(20.2)	165	(15.7)	367	(17.9)
60–69	14	191	(19.1)	132	(12.6)	323	(15.7)
70+	17	168	(16.7)	166	(15.8)	334	(16.2)
Missing	-	1	(0.1)	0	(0)	1	(0)
Location by state/territory[s]							
NSW	31	287	(28.6)	285	(27.1)	572	(27.8)
VIC	25	302	(30.1)	399	(38.0)	701	(34.1)
QLD	20	205	(20.4)	194	(18.5)	399	(19.4)
SA	8	88	(8.8)	85	(8.1)	173	(8.4)
WA	10	93	(9.3)	73	(7.0)	166	(8.1)
TAS	2	16	(1.6)	13	(1.2)	29	(1.4)
ACT	2	8	(0.8)	0	(0)	8	(0.4)
NT	1	0	(0)	0	(0)	0	(0)
Missing	-	6	(0.6)	0	(0)	6	(0.3)
Location by remoteness area[s]							
Major Cities of Australia	72	775	(77.1)	835	(79.5)	1,610	(78.3)
Inner Regional Australia	18	156	(15.5)	152	(14.5)	308	(15.0)
Outer Regional Australia	8.2	60	(6.0)	57	(5.4)	117	(5.7)
Remote/very remote Australia	1.9	10	(1.0)	5	(0.5)	15	(0.7)
Missing	-	4	(0.4)	2	(0.2)	6	(0.3)
Income							
Top third	30	72	(7.2)	105	(10.0)	177	(8.6)
Middle third	30	435	(43.3)	456	(43.4)	891	(43.3)
Bottom third	30	356	(35.4)	304	(28.9)	660	(32.1)
Missing	-	142	(14.1)	186	(17.7)	328	(16.0)
Education							
University/Postgraduate degree	52	609	(60.6)	185	(17.6)	795	(38.7)
TAFE		*Not asked*		270	(25.7)	*na*	*na*
Secondary/high school	45	364	(36.2)	250	(23.8)	614	(29.9)
Primary school or less	3	19	(1.9)	20	(1.9)	39	(1.9)
Missing	-	13	(1.3)	326	(31.0)	339	(16.5)
Living with other adults (18 years and over)							
No other adults		134	(13.3)	119	(11.3)	253	(12.3)
1 adult		354	(35.2)	349	(33.2)	703	(34.2)
2 adults		362	(36.0)	371	(35.2)	733	(35.7)
3 or more adults		150	(14.9)	191	(18.2)	341	(16.6)
Missing		5	(0.5)	21	(2.0)	26	(1.3)

(Continued)

	Australian population	Round 1		Round 2		Total	
	(%)	n	(%)	n	(%)	n	(%)
Living with children (under 18 years)							
No children		731	(72.7)	768	(73.1)	1499	(72.9)
1–2 children		224	(22.3)	214	(20.4)	438	(21.3)
3 or more children		41	(4.1)	42	(4.0)	83	(4.0)
Missing		9	(0.9)	27	(2.6)	36	(1.8)
Primary job sector before COVID-19				233	(22.5)		
Professional				92	(8.9)		
Manager				44	(4.3)		
Technician or associate professional				111	(10.7)		
Clerical support worker				87	(8.4)		
Service and sales worker				5	(0.5)		
Skilled agricultural, forestry, and fishery worker				21	(2.0)		
Craft and related trades worker				14	(1.4)		
Plant and machine operator and assembler				17	(1.6)		
Elementary occupations				2	(0.2)		
Armed forces occupations				243	(23.5)		
Other				167	(16.1)		
Missing				233	(22.5)		

Response rate for new participants was 10% and 63% for repeated surveys (participants who did surveys in both rounds). Participant ages ranged between 18 and 99 years, with median age of 49 years (IQR: 34–64).
[S]Representative sampling for key demographics of Australian population was done by sex, age, and residential location. Overall, there were n = 2,056 study surveys completed.

sampling was targeted to underrepresented groups to align with population characteristics.

Setting

Postcodes were provided by survey participants and mapped to the Australian Bureau of Statistics (ABS) remoteness areas using ABS data cubes (11, 12). Postcodes were coded by socioeconomic index for areas (SEIFA) (11, 12). Specifically, the index of relative socioeconomic disadvantage (IRSD) was applied and divided into five quintiles, from 1 (most disadvantaged) to 5 (most advantaged).

Data Analysis

Data screening ensured data usability and an integrity script allowed discarding of surveys with <10% completion. Descriptive statistics were calculated for key survey variables for each of the two rounds of surveys. Regression analyses are described below. Multicollinearity was tested by examining the variance inflation factor (VIF) of all the variables included in the regression models. Any variable whose VIF values were >5 were further investigated for multicollinearity (13).

Longitudinal Survey Analyses

Mixed effects regression analyses were done with the individual specified as random effects to account for repeated measures.

Mixed effects ordinal logistic regressions were then applied to examine characteristics around likelihood of adhering to three key behavioural interventions designed to limit the spread: (1) physical distancing; (2) self-quarantining; and (3) getting tested when symptoms develop. The dependent variable was likelihood of adhering to the behaviour (4 = extremely likely; 3 = somewhat likely; 2 = unlikely, and 1 = very-unlikely) and treated as ordinal as it has a natural ordering. Ordinal logistic regression requires the proportional odds assumption to be met and this was assessed using a likelihood-ratio test of whether the coefficients are equal across categories [using *omodel* and *brant, detail* (14)]. When indicated, output from the ordinal logistic regressions are displayed as proportional odds ratios. Independent variables specified as fixed effects included: sex; age-group; area IRSD; state; rurality; and education. Initial mixed effects regressions examined these independent variables, and those with $p < 0.2$ were included in the final multivariate mixed effects regression.

Additional Analyses With the Cross-Sectional Second Survey

The second survey had additional questions, which enabled profiling of participants in regard to adherence of the three public health behaviours promoted in Australia to limit SARS-CoV-2 spread. These questions captured the likelihood of adhering to: (1) physical distancing; (2) self-quarantining; and (3)

getting tested when symptoms develop. Using this information, adherence behaviour is displayed in a Sanskey diagram (15). Then profiles of people with varying adherence were created using these questions. The "adherent in all three measures" group were the participants who responded "most-of-the-time" in all three questions. The "non-adherent in at least one of the three measures" group were those who didn't respond "most-of-the-time" in all three questions. The "non-adherent in all three measures" group were those not responding "most-of-the-time" in any of the three questions. The "non-adherence of 'never'" group were those who responded "never" to the three measures.

RESULTS

Participants

The first survey round was completed by $n = 1,005$ participants and the second survey round by 1,051. Overall 2,056 surveys were completed in both survey rounds 1 and 2, and 63% (1,294/2,056) were longitudinal with 647 individuals completing both surveys. Another 762 individuals completed one of the rounds of the survey. The response rate was 10% overall and was 63% in those providing longitudinal data.

Ages ranged from 18 to 99 years (median 53, IQR: 34–64). Key demographics are shown in **Table 1**. **Table 1** also shows expected proportions in the general Australian population. The sample obtained captured a large, representative sample of the adult Australian population across age, sex, location, and socioeconomic status.

Main Findings From the Longitudinal Surveys

Overall, we found the reported knowledge of Australian policies was generally high, see **Supplementary Table 2**.

Table 2 show the reported policy adherence on behaviours the government or health agencies recommended in response to the COVID-19 pandemic, and the degree that each has been adopted as reported by these survey participants in Australia. It shows that the majority of Australians reported being adherent "most of the time" for all policy recommended behaviours. Adherence on public health policy regarding physical distancing, self-quarantining and getting a test for COVID-19 are detailed below, and profiles of those who are likely (or not) to report adherence are also provided.

Physical Distancing

Not physically distancing most-of-the-time was reported in over 1-in-4 in both survey rounds with differences by sex and age: For round 1, 27% men vs. 23% women ($p > 0.05$) and 38% under 30 years vs. 19% >30 years ($p < 0.001$); and for round 2, 31% men vs. 26% women ($p = 0.04$) and 46% under 30 years vs. 31% >30 years ($p < 0.001$), see **Figure 1** and **Table 2**. Mixed effects multivariate regression confirmed that after adjusting for time, age-group, location and education level, women had higher odds for physical distancing (odds ratio 1.75, 95% confidence interval 1.25–2.45) compared to men, see **Table 3A**. Generally, older age groups displayed higher odds for physical distancing. For example, compared to those aged 18–29 years: the odds ratio for those 40–49 years was 3.27 (1.88–5.67); 50–59 years was 4.31

(2.49–7.45); 60–69 years was 8.33 (4.54–15.30), and; 70 years and over was 8.69 (4.60–16.40).

Self-Quarantining

Figure 1 shows that in both rounds, sub-optimal policy adherence was evident including not self-quarantining most-of-the-time in 1-in-4 when unwell with large differences by sex: For round 1, 29% men vs. 17% women ($p < 0.01$); and round 2, 36% men vs. 16% women ($p < 0.001$). There also appeared to be some differences by age: for round 1, 31% under 30 years vs. 23% >30 years ($p = 0.12$); and round 2, 34% under 30 years vs. 25% >30 years ($p = 0.04$). Mixed effects multivariate regression showed no differences between rounds 1 and 2 when examining the self-quarantine results. Mixed effects regression showed women more likely to self-quarantine compared to men when unwell (odd ratio 3.35; 1.87–5.99), see **Table 3B**. Generally, older age groups displayed higher odds for self-quarantining. For example, compared to those aged 18–29 years: the odds ratio for those 50–59 years was 3.20 (1.29–7.95), and; 70 years and over was 6.10 (2.09–17.84).

Testing

Figure 1 shows that having a test as soon as you have symptoms (only asked in the second survey round) was also sub-optimal: 59% men vs. 72% women ($p < 0.001$) and 56% under 30 years vs. 68% >30 years ($p = 0.01$). Similar results were reported for seeing a doctor or seeking a test if you have symptoms: 54% men vs. 73% women ($p < 0.001$) and 50% under 30 years vs. 66% >30 years ($p = 0.001$). Mixed effects multivariate regression showed that after adjusting for time, age-group and education level, women had higher odds, compared to men, see a doctor or seek a test if symptomatic (2.25; 1.51–3.45), see **Table 3C**. As with the physical distancing and self-quarantining results reported above, there was a general trend for higher odds ratios in the older age groups (compared to the youngest group of 18–29 years) and this was significant for those 60–69 years with 3.09 (1.44–6.61), and; 70 years and over with OR 3.58 (1.81–7.07).

Multicollinearity

In all the regressions mentioned below, all independent variables had VIFs that were <1, indicating minimal multicollinearity.

Main Findings Arising From the Additional Questions in the Round Two Survey

Profiles of Adherence

In the second round of the survey, 323 participants responded to all three key public health measure items: physical distancing, self-quarantining and getting tested, see **Figure 2**. The remaining participants responded "not applicable" to at least one of these questions and were excluded for the subgroup analyses. Subgroups were then generated across levels of adherence. There were 57% (185/323) in the "adherent in all three measures" group, and 43% (138/323) in the "non-adherent in at least one of the three measures" group. There were 19% (60/323) in the "non-adherent in all three measures" group. There were 2.5% (8/323) in the "non-adherence of 'never'" group. **Supplementary Table 4** shows the demographics of these groups.

TABLE 2 | Policy adherence on behaviours the government or health agencies recommended in response to the COVID-19 pandemic, and the degree that each has been adopted as reported by participants in Australia.

	Round 1 (n = 1,005)										Round 2 (n = 1,056)										
	Total		Most of the time		Some of the time		Seldom		Never		Total		Most of the time		Some of the time		Seldom		Never	
	n	(%)	*n*	(%)	*N*	(%)	*n*	(%)	*n*	(%)	*n*	(%)	*n*	(%)	*n*	(%)	*n*	(%)	*n*	(%)
Hand washing with soap and water for 20 s	992	(100.0)	773	(77.9)	163	(16.4)	40	(4.0)	16	(1.6)	1,034	(100)	749	(72.4)	209	(20.2)	57	(5.5)	19	(1.8)
Using hand sanitizer	980	(100.0)	460	(46.9)	326	(33.3)	141	(14.4)	53	(5.4)	1,031	(100)	562	(54.5)	344	(33.4)	92	(8.9)	33	(3.2)
Coughing/sneezing into your elbow	947	(100.0)	666	(70.3)	169	(17.8)	59	(6.2)	53	(5.6)	1,005	(100)	731	(72.7)	170	(16.9)	67	(6.7)	37	(3.7)
Wearing a face mask every time you go out of your home***	947	(100.0)	107	(11.3)	79	(8.3)	126	(13.3)	635	(67.1)	1,009	(100)	83	(8.2)	109	(10.8)	160	(15.9)	657	(65.1)
Wearing a face mask on public transport or crowded areas***	-		-		-		-		-		727	(100)	115	(15.8)	73	(10.0)	89	(12.2)	450	(61.9)
Staying at least 1.5–2 m away from other people	971	(100.0)	729	(75.1)	169	(17.4)	42	(4.3)	31	(3.2)	1,031	(100)	734	(71.2)	213	(20.7)	63	(6.1)	21	(2.0)
Staying/working at home rather than going to work or school	703	(100.0)	471	(67.0)	92	(13.1)	47	(6.7)	93	(13.2)	678	(100)	344	(50.7)	126	(18.6)	57	(8.4)	151	(22.3)
Avoiding getting take-out food or delivery	877	(100.0)	289	(33.0)	181	(20.6)	183	(20.9)	224	(25.5)	902	(100)	230	(25.5)	169	(18.7)	199	(22.1)	304	(33.7)
Avoiding all social gatherings (large and small)	953	(100.0)	768	(80.6)	105	(11.0)	43	(4.5)	37	(3.9)	959	(100)	460	(48.0)	271	(28.3)	129	(13.5)	99	(10.3)
Avoiding any non-essential travel	931	(100.0)	734	(78.8)	123	(13.2)	47	(5.0)	27	(2.9)	944	(100)	618	(65.5)	174	(18.4)	81	(8.6)	71	(7.5)
Avoiding using public transportation (except essential service workers)	678	(100.0)	499	(73.6)	79	(11.7)	46	(6.8)	54	(8.0)	594	(100)	355	(59.8)	121	(20.4)	65	(10.9)	53	(8.9)
Limiting public transport use to allow for physical distancing	-		-		-		-		-		595	(100)	342	(57.5)	114	(19.2)	63	(10.6)	76	(12.8)
Self-quarantining if you have or believe you have the virus	395	(100.0)	301	(76.2)	43	(10.9)	24	(6.1)	27	(6.8)	373	(100)	271	(72.7)	39	(10.5)	39	(10.5)	24	(6.4)
Self-isolating if you have been in contact for over 15 min with others who are awaiting test results	-		-		-		-		-		343	(100)	220	(64.1)	51	(14.9)	35	(10.2)	37	(10.8)
Self-quarantine at home if you have symptoms and are awaiting a COVID-19 result	-		-		-		-		-		416	(100)	296	(71.2)	60	(14.4)	29	(7.0)	31	(7.5)
Self-quarantine if you have had close contact with a confirmed case	-		-		-		-		-		379	(100)	248	(65.4)	63	(16.6)	33	(8.7)	35	(9.2)
Having a test as soon as you have symptoms	-		-		-		-		-	-	397	(100)	258	(65.1)	60	(15.1)	37	(9.3)	42	(10.6)
See a doctor or seek a test if you have symptoms	-		-		-		-		-	-	469	(100)	293	(62.5)	75	(16.0)	47	(10.0)	54	(11.5)

Round 1 surveys were completed during May 1st to 5th, 2020; and round 2 surveys completed during July 1st to 7th, 2020.
***Not government policy in Australia at that time.

FIGURE 1 | Proportion of Australians in May (round 1) and July (round 2) reporting non-adherence to physical distancing (at least 1.5 m away from other people), self-isolation when unwell (you have or think you have the virus) and having a test as soon as you have symptoms. Most-of-the-time responses provided to the question on: physical distancing was 73.1% (95% CI: 71.1–75.0); self-quarantining when unwell was 74.3% (95% CI: 72.4–76.1), and; having a test as soon as you have symptoms was 65.0% (95% CI: 60.1–69.7). *Significant difference between groups ($p < 0.05$).

In the "adherent in all three measures" group, 54% (99/185) were women and 70% (129/185) were aged 40 years and over (**Supplementary Table 3A**). In the people who indicated "non-adherence in at least one of the three measures," 64% (88/138) were men and 65% (42/138) were aged under 40 years (**Supplementary Table 3B**). In the "non-adherent in all three measures," 75% (45/60) were men and 70% (42/60) were aged under 40 years (**Table 3C**). In those who responded "never" in each question, all (8/8) were men and 63% (5/8) were aged under 40 years, and the remaining 37% (3/8) were aged between 40 and 59 years (**Supplementary Table 3D**).

Supplementary Table 5 shows the concerns reported by the above adherent profile groups, and the overall round 2 participants ($n = 1,051$). Those in any of the "non-adherent" groups reported much lower concerns than those in the "adherent" group.

Supplementary Table 6 shows the things that would convince participants to practice social/physical isolation or distancing reported by round 2 participants ($n = 1,051$) and by the above adherent profile groups. Those "non-adherent in all three measures" reported very few strategies that would motivate them to adhere.

Reported attitudes on importance (**Supplementary Table 7A**) and severity (**Supplementary Table 7B**) of government measures to reduce COVID-19 spread, show that 81% (835/1,032) considered these "very important." In those adherent in all three questions, 91% (164/181) considered these "very important," compared with 22% (13/59) in those who indicated "non-adherent in all three measures." Overall 75% (772/1,029) considered the severity of government measures "about right," while only 5% (51/1,029) considered government measures "too

strict." In those who indicated adherence to all three questions, only 1.6% (3/183) considered measures "too strict," compared with 22% (13/60) among those in the "non-adherent in all three measures" group.

Participants were also asked to list barriers to having a COVID-19 test (**Supplementary Table 8**). The most commonly cited responses were "having to request your contacts to isolate" (21%), "having to isolate until results return (20%), "don't know where to get a test" (15%), and "inconvenience of obtaining a test" (15%). Compared to those who were adherent in all three key behaviours, those who were non-adherent in all three behaviours were more likely to be deterred by "inconvenience in obtaining a test" (22 vs. 12%).

Information Sources

Figure 3 shows the majority of participants sourced information from conventional media sources, including 50% of people utilising the public broadcaster, the Australian Broadcasting Corporation (ABC). In round 1, 74% of the population sourced information from the national leader, making it the second most popular source of information after conventional media sources. However, in round 2, "local health authorities and government" were the second most popular source of information, being utilised by 73% of respondents. Young people were more likely to report using other media sources such as social media.

DISCUSSION

The COVID-19 pandemic continues to have major health, psychosocial and economic impacts (1, 16), with Australia having successfully reduced cases following two waves, the

TABLE 3A | Regression analyses: Physical distancing by staying at least 1.5–2 m away from other people.

Outcome	Independent variable		N	Univariate				Multivariate[B]			
				OR	95% C		p-value	OR	95% C		p-value
					Lower	Upper			Lower	Upper	
Physical distancing	Time	Round 1	971	1.18	0.91	1.52	0.21				
		Round 2	1,031	(ref)	-	-	-				
	Gender	Men	1,008	(ref)	-	-	-	(ref)	-	-	-
		Women	980	1.56	1.10	2.20	0.01*	1.75	1.25	2.45	<0.01*
	Age group	18–29 yo	344	(ref)	-	-	-	(ref)	-	-	-
		30–39 yo	343	0.90	0.55	1.49	0.69	0.89	0.54	1.47	0.56
		40–49 yo	305	3.29	1.89	5.71	<0.01*	3.27	1.88	5.67	<0.01*
		50–59 yo	361	4.30	2.49	7.43	<0.01*	4.31	2.49	7.45	<0.01*
		60–69 yo	319	8.44	4.64	15.32	<0.01*	8.33	4.54	15.30	<0.01*
		70 yo and over	329	8.53	4.60	15.83	<0.01*	8.69	4.60	16.40	<0.01*
	IRSD quintile	(poorest) 1	309	(ref)	-	-	-				
		2	373	1.17	0.77	1.54	0.62				
		3	428	1.12	0.71	1.38	0.97				
		4	404	0.83	0.54	1.15	0.26				
		(richest) 5	483	1.05	0.71	1.35	0.89				
	Major Cities	Other	435	(ref)	-	-	-	(ref)	-	-	-
		Major Cities	1,567	0.61	0.39	0.93	0.02*	1.03	0.69	1.56	0.94
	Major States	NSW	556	(ref)	-	-	-				
		VIC	680	1.06	0.81	1.34	0.74				
		QLD	391	0.91	0.70	1.24	0.64				
		Other	375	1.38	0.86	2.34	0.32				
	Highest edu	Secondary or less	629	(ref)	-	-	-	(ref)	-	-	-
		College / University	1,337	0.72	0.49	1.04	0.07	1.08	0.77	1.53	0.68

Outcome has categories of: 4 = most of time; 3 = some of time; 2 = seldom, and; 1 = never.
[B]Independent variables in the multivariate model are: sex, age-group, rurality, and highest education.

second one focused in one state (Victoria) (2). Public health policies and behavioural change remain our primary defence (4). Here we report COVID-19 related attitudes, knowledge, concerns, and behaviours in Australia after suppression of the first wave (survey round 1) and 2 months later at the beginning of the second wave (survey round 2). Timing of the second survey round is important because the COVID-19 wave 2 was subsequently localised to Victoria, yet at the time of the second survey all areas in Australia were anxiously anticipating potential increases in cases, which might account for why our survey data didn't produce differential results when broken down by state. Overall, we found that knowledge of Australian policies was generally high, yet one in four reported non-adherence to physical distancing and self-quarantining, and one in three to testing when unwell. This likely accounts for the community transmission causing wave 2 following cases contracted from returned travellers in quarantine at city hotels especially in Victoria (2, 17). Understanding those for which adherence was lower, is crucial for designing additional and future strategies, and as seen globally, in Australia this was males and young people. Those who were non-adherent to all three policy measures reported fewer COVID-19 related concerns

and were less likely to respond to behavioural motivators such as education and to regulatory, punitive measures. Overall interpretation from the Australian data is consistent with the evidence on what to do to promote adherence during pandemics (18) that education, consistent messaging, addressing concerns and motivators and providing support are all critical for behaviour change (3, 5–7), which then controlled the second wave. However, given persistent limited adherence largely in young adults and men, a geographically focused second wave required lockdown restrictions with threats of punitive outcomes. In the context of consistent communication, financial support and free healthcare, restrictive and punitive measures were generally supported and accepted as not overly restrictive and the second wave was controlled.

Behavioural and social sciences provide vital insights to enable and support behaviour change (1, 4, 19, 20). Behavioural adherence to viral spread prevention policies, can be understood through established behaviour change theories such as capability, opportunity and motivation (COM-B) and the Health Beliefs model (HBM) (3, 5–7). Examples from the data on those that are less adherent that are consistent with these models included: greater concerns of not having enough money for

TABLE 3B | Regression analyses: Self-quarantining if you are unwell (i.e., if you have or believe you have the virus).

Outcome	Independent variable		N	Univariate				Multivariate[B]			
				OR	95% C		p-value	OR	95% C		p-value
					Lower	Upper			Lower	Upper	
Self-quarantining if you have or believe you have the virus	Time	Round 1	395	1.41	0.88	2.21	0.13	1.26	0.81	1.95	0.31
		Round 2	373	(ref)	-	-	-	(ref)	-	-	-
	Gender	Men	416	(ref)	-	-	-	(ref)	-	-	-
		Women	347	3.61	1.97	6.63	<0.01*	3.35	1.87	5.99	<0.01*
	Age group	18–29 yo	145	(ref)	-	-	-	(ref)	-	-	-
		30–39 yo	161	0.49	0.23	1.03	0.07	0.50	0.24	1.06	0.07
		40–49 yo	117	1.45	0.63	3.33	0.38	1.37	0.59	3.17	0.47
		50–59 yo	126	3.16	1.29	7.72	<0.01	3.20	1.29	7.95	0.01*
		60–69 yo	106	2.74	1.11	6.74	<0.03	2.25	0.91	5.60	0.08
		70 yo and over	113	6.55	2.31	18.60	<0.01*	6.10	2.09	17.84	<0.01*
	IRSD quintile	(poorest) 1	120	(ref)	-	-	-				
		2	146	0.98	0.39	2.46	0.78				
		3	160	1.20	0.49	2.96	0.97				
		4	145	0.86	0.76	2.17	0.42				
		(richest) 5	196	1.59	0.32	3.91	0.53				
	Major Cities	Other	140	(ref)	-	-	-	(ref)	-	-	-
		Major Cities	628	0.52	0.25	1.11	0.09	0.84	0.40	1.73	0.62
	Major States	NSW	230	(ref)	-	-	-				
		VIC	271	1.01	0.51	2.02	0.80				
		QLD	130	0.80	0.35	1.85	0.70				
		other	137	0.88	0.39	2.02	0.90				
	Highest edu	Secondary or less	226	(ref)	-	-	-				
		College / University	525	0.69	0.39	1.23	0.21				

Outcome has categories of: 4 = most of time; 3 = some of time; 2 = seldom, and; 1 = never. [B]Independent variables in the multivariate model are: survey round, sex, age-group, and rurality.

food and rent (capability [COM-B]) or accessing COVID-19 testing [perceived barriers (HBM), opportunity (COM-B)]; lower perceived risk from COVID-19 [perceived susceptibility (HBM), motivation (COM-B)]; and lower perceived importance of government measures [perceived severity (HBM), motivation (COM-B)]. These aspects can be leveraged to develop appropriate intervention plans for future potential waves of COVID-19 infections.

Behaviour is underpinned by knowledge, attitudes and beliefs (3, 5–7). To change behaviour, policies need to influence knowledge, attitudes and beliefs and provide the opportunity, capability and motivation to change. Diverse policy approaches include education, incentives and enablers and regulation focused on physical distancing, isolating when unwell or diagnosed and testing if unwell, all vital in slowing the spread of COVID-19. In most countries, including Australia, these policy approaches have been largely successful through consistent messaging, addressing concerns and motivators, and providing support for behaviour change (see **Supplementary Table 2**). However, during a crisis such as the beginning of the second wave, these were not been sustainably achieved through individual behaviour alone. In the state of Victoria, border control, regulated strict extended lock downs and punitive

measures were needed, in addition to vigorous contact tracing and testing. Additional extensive policy measures implemented included: individual and business financial support, free universally accessible testing and healthcare, reimbursement to cover testing time and sick leave for self-quarantine. Over 70% supported government policies and felt they were appropriate with very few public protests (21). The second COVID-19 wave was later successfully controlled bringing locally acquired cases down from 701/day to 28/day in 6 weeks, and to zero in another 6 weeks (2).

To prevent further waves and lockdowns, optimising behavioural policy adherence is critical.

Regarding physical distancing policy adherence, we report that one in four Australians, especially young adults and men, do not adequately adhere to relevant policies, aligned with other COVID-19 (22, 23), and prior pandemic studies (24). Modelling suggests that 90% of the Australian population needs to physically distance, whilst viral control is not possible with 70% adherence, even with concomitant case isolation (25). Here, knowledge on physical distancing policies were high; however, attitudes and beliefs were problematic in young adults and young men, with non-adherers endorsing few of the concerns and motivators to change within the survey, highlighting the

TABLE 3C | Regression analyses: Having a test as soon as you have symptoms (top) and see a doctor or seek a test if you have symptoms (bottom).

Outcome	Independent variable		N	Univariate				Multivariate[B]			
				OR	95% CI		p-value	OR	95% CI		p-value
					Lower	Upper			Upper	Lower	
Having a test as soon as you have symptoms	Gender	Men	209	(ref)	-	-	-	(ref)	-	-	-
		Women	185	2.40	0.98	5.95	0.06	1.76	1.13	2.73	<0.01*
	Age group	18–29 yo	99	(ref)	-	-	-	(ref)	-	-	-
		30–39 yo	82	0.55	0.32	0.94	0.03*	0.54	0.31	0.92	0.03*
		40–49 yo	62	1.73	0.89	3.37	0.11	1.65	0.83	3.27	0.16
		50–59 yo	56	2.14	1.04	4.40	0.04*	2.08	1.00	4.30	0.05
		60–69 yo	41	2.62	1.11	6.17	0.03*	2.17	0.91	5.22	0.08
		70 yo and over	57	3.56	1.59	7.94	<0.01*	3.37	1.47	7.60	<0.01*
	IRSD quintile	(poorest) 1	59	(ref)			-				
		2	73	0.75	0.30	1.92	0.54				
		3	83	1.01	0.41	2.46	0.99				
		4	87	1.02	0.42	2.47	0.99				
		(richest) 5	95	1.15	0.47	2.78	0.82				
	Major Cities	Other	73	(ref)	-	-	-	(ref)	-	-	-
		Major Cities	324	0.66	0.38	1.14	0.14	0.89	0.46	1.73	0.73
	Major States	NSW	98	(ref)	-	-	-				
		VIC	166	1.14	0.69	1.88	0.61				
		QLD	70	1.04	0.56	1.92	0.90				
		other	36	1.38	0.70	2.71	0.35				
	Highest edu	Secondary or less	105	(ref)	-	-	-				
		College / University	278	0.89	0.55	1.42	0.62				
See a doctor or seek a test if you have symptoms	Gender	Men	264	(ref)	-	-	-				
		Women	202	2.28	1.55	3.56	<0.01*	2.25	1.51	3.45	<0.01*
	Age group	18–29 yo	111	(ref)	-	-	-	(ref)	-	-	-
		30–39 yo	91	0.85	0.51	1.41	0.52	0.89	0.55	1.51	0.69
		40–49 yo	71	1.76	0.97	3.21	0.06	1.75	0.94	3.24	0.08
		50–59 yo	67	1.42	0.79	2.57	0.24	1.46	0.80	2.67	0.21
		60–69 yo	53	3.14	1.49	6.63	<0.01*	3.09	1.44	6.61	<0.01*
		70 yo and over	76	3.30	1.70	6.40	<0.01*	3.58	1.81	7.07	<0.01*
	IRSD quintile	(poorest) 1	81	(ref)			-	(ref)			-
		2	96	1.62	0.77	2.49	0.29	1.58	0.84	2.96	0.14
		3	83	2.33	0.94	3.25	0.12	1.72	0.85	3.45	0.10
		4	96	1.63	0.75	2.38	0.29	1.48	0.79	2.76	0.20
		(richest) 5	113	2.58	1.03	3.24	0.08	1.93	0.97	3.84	0.05
	Major Cities	Other	95	(ref)	-	-	-				
		Major Cities	374	0.81	0.51	1.29	0.38				
	Major States	NSW	117	(ref)	-	-	-				
		VIC	182	1.05	0.66	1.66	0.83				
		QLD	88	0.92	0.53	1.58	0.76				
		other	82	1.09	0.61	1.93	0.78				
	Highest edu	Secondary or less	115	(ref)	-	-	-				
		College / University	339	0.90	0.58	1.40	0.65				

Only asked in the second survey round. Outcome categories of: 4 = most of time; 3 = some of time; 2 = seldom, and; 1 = never. [B]Independent variables in the multivariate models are those with outputs shown.

potential need for regulatory measures in a subgroup of the population. This aligns with the reported strong community support for government policies and general support for the severity of current government regulations in Australia (21, 26).

Perceptions of a lack of policy importance or undue severity were most prominent among those who did not adhere to physical distancing, self-quarantine and testing if unwell, which is consistent with the reported lack of concerns around COVID-19.

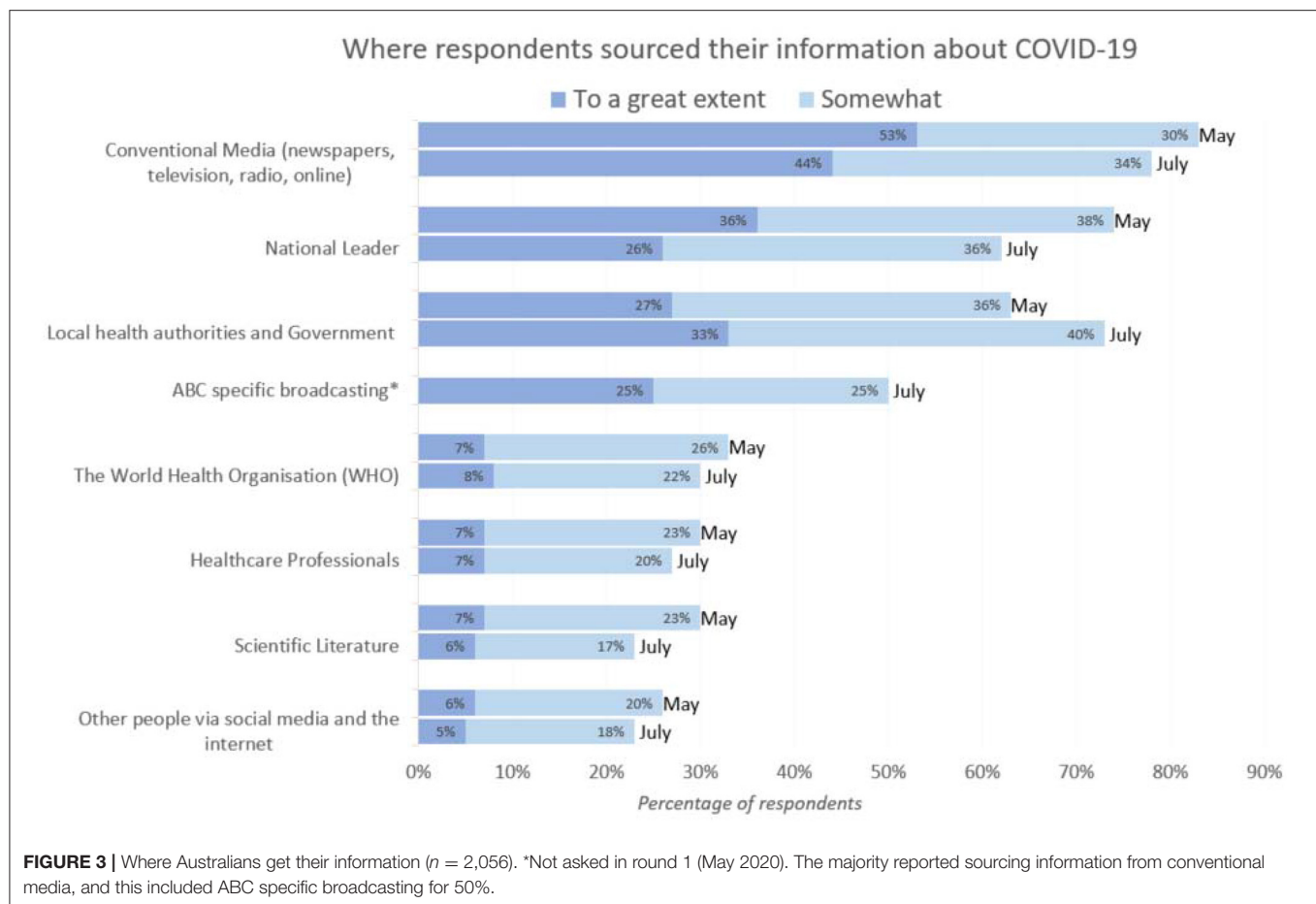**FIGURE 2 |** Responses to three key public health measure on physical distancing, self-quarantining, and getting tested. These three measures were available from n = 323 participants in round 2. Those "adherent in all three measures" (57%; 185/323) responded "most-of-the-time" in all three questions. "Non-adherent in at least one measure" were 43% (138/323). "Non-adherent in all three measures" were 19% (60/323). A small group responded "never" in each question (2.5%; 8/323).

Self-quarantine when unwell or COVID-19 positive, when returning from overseas travel, after potential contact with a known case, or if testing positive, is crucial to contain COVID-19 (27). While it is intuitive to quarantine when unwell, it remains equally important in other scenarios, particularly as we learn more about significant levels of pre-symptomatic (28) and asymptomatic (29) transmission. Even limited non-adherence can lead to widespread community transmission, as seen through reports of "super-spreaders" (30, 31). Indeed Australia's outbreak appears, on genomic testing, to have come from a single family of four returning from overseas (32). In light of this, reported high-levels of non-adherence to self-quarantining are very concerning. Despite being aware of policy recommendations and being concerned about infecting others, nearly a quarter of older people and a third of younger people and men, reported non-adherence to self-quarantining in both rounds of the survey. This is consistent with recent data collected by the Australian Defence Force through door-knocking, with reports that one in four people with confirmed infection, were not at home despite being instructed to quarantine (33). The factors underpinning quarantining non-adherence are likely complex and multifactorial. Motivation to quarantine may be affected by a poor risk perception (34), optimism bias (35), and high levels of concern in young people about being socially isolated. Furthermore, individuals may have reduced capability to self-quarantine due to the economic costs, and fears over job security (36). In order to mitigate any financial barriers to self-quarantining and testing, policy makers have since introduced a $1,500 payment to those who test positive, and $300 for Victorians who can't work while they're awaiting test results.

This policy is supported by research from Israel suggesting that financial compensation can significantly improve COVID-19 quarantine adherence (37).

With regards to testing behaviours, in the midst of the July second COVID-19 wave, one third of our respondents were non-adherent to testing at the onset of symptoms. A concurrent, non-representative survey found non-adherence to be as high as 55% (38). Our findings appear consistent with reports that 30% of international travellers refused to be tested in Australia's quarantine hotels (39). Testing is vital in case identification, quarantine and contact tracing, especially as COVID-19 can be asymptomatic (40). On average, each person has around 9 close contacts (41). With every day that an individual delays getting tested after developing symptoms, the number of contacts for tracing and viral spread increases. A recent study found that a delay in testing of 3 days or more, would render even the most efficient contract tracing regimes unable to bring the R0 (effective reproduction number) below one (40). There is evidence that contact tracing in Victoria was overwhelmed, a key driver for the government to implement stage 4 lockdown (42). There are many factors that may underpin suboptimal testing adherence. Testing is free for everyone in Australia, residents and non-residents, so cost was not a factor. Among our participants, the most commonly cited concern about getting tested was "having to ask contacts to self-isolate." This may point to the role of social stigma (43) adversely impacting motivation to be tested, as has been reported across Asia (44). Similarly, individuals' capability to be tested may be reduced by poor communication (45) about testing locations and inconvenience of getting to a test site. Sites for testing were increased over time, now with over 190 across

FIGURE 3 | Where Australians get their information (*n* = 2,056). *Not asked in round 1 (May 2020). The majority reported sourcing information from conventional media, and this included ABC specific broadcasting for 50%.

the state of Victoria, and are a mix of pop up sites in high risk areas, walk-in, drive through, primary care, pathology, and hospital based with wait times available online. Additionally, a more recent option is "call-to-test" where in home testing is provided for those experiencing injury, health, mobility or other issues that impede their ability to leave home or their careers. At times in identified high risk areas, there was also door to door testing offered. Whilst testing is free to all residents and non-residents there are financial burdens associated with missing work and self-quarantining particularly for young people, who are more likely to be part of the casual workforce without access to sick leave (36). Hence government policies implemented in the second COVID-19 wave, which provided financial compensation for individuals/parents/carers of those getting tested and staying home, were probably important. This included (Aus $450) for testing and staying home whilst waiting for a result, as well as funding pandemic leave at normal pay for 2 weeks for those not able to access sick leave (e.g., casual workers, self -employed). Pandemic leave was available for a number of situations including: symptoms consistent with COVID-19, and isolating as a close contact of a suspected/known case of COVID-19.

To guide targeted policy interventions, we analysed survey responses by varying levels of adherence to our three key

behaviours; physical distancing, self-quarantining and getting tested. Those who were non-adherent to all three measures, were more likely to be younger, male and liver in major cities. These trends are consistent with behavioural data from previous pandemics (24) and may speak to the role of risk perception in enacting behaviour change, as theorised in the Health Beliefs model (5). For example, during the SARS outbreak in 2003, women and older people were more likely to perceive themselves as high risk, and also more likely to adhere to behavioural policies such a quarantine (34). Similarly, our data shows that those who were non-adherent across all three behaviours reported significantly lower concerns around COVID-19, were more likely to consider government measures ineffective or too "strict," than those who were adherent across all three behaviours. To increase adherence in this group, local health authorities and government should focus on emphasising the risks and consequences of contracting SARS-CoV-2. Those who were non-adherent in all three behaviours, were also far less responsive to common motivators of policy adherence (e.g., education and punitive measures). The exception to this, was a significant proportion of non-adherent individuals who reported that they would be motivated by information showing how their actions saved lives. Interestingly, research from the United Kingdom and Germany has found that inducing empathy for society's most

vulnerable increases behavioural adherence during the COVID-19 pandemic, and presents a potential strategy for government messaging to a group which is otherwise difficult to target (46). Potentially engaging role models, emphasising social norms (the majority who do adhere) may be useful (1); however, these findings also emphasise that for the small majority, government regulation and punitive measures remain important (1). This is akin to public health approaches such as in smoking, and driving behaviours which involve education, incentives and regulation.

The interpretation from the Australian data is that education, consistent messaging, addressing concerns and motivators and providing support are all critical for behaviour change. However, in the context of an escalation in cases, as in the Australian second COVID-19 wave, restrictions with threats of punitive outcomes, are likely to have a role and that if these occur in the context of widespread education, consistent targeted messaging, financial support for the vulnerable populations, then they are reasonably well-tolerated, seen to be fair and not overly restrictive.

Strengths and Limitations

This research captured a large, representative sample of the adult Australian population across age, sex, location, and socioeconomic status. The survey questionnaire was based on established behavioural theories and we were able to compare findings at two separate time points. As the Australian arm of the international iCARE survey, our data can be subsequently compared with other countries. Our survey was only available in English, which will have led to an underrepresentation of ethnic groups. There is also no data on subgroups such as single mothers, at higher risk of economic and psychosocial stressors. As the survey was voluntary, our sample may be prone to selection bias. We also rely on self-reported behaviour, which may have led to socially desirable traits being over reported (social desirability bias) (47); however, this may be mitigated by the anonymity of survey responses. Only 323 completed the provided responses to three key public health measures on physical distancing, self-quarantining and getting tested as for many, self-quarantine, and testing had not been indicated.

CONCLUSION

Australia is emerging from a second wave of COVID-19, with Victoria worst affected and currently in stage four lockdown. This nationally representative survey examined adherence to three key behaviours critical to limiting the spread of COVID-19, as key targets for health policy. In both May and July 2020, adherence to key policies was suboptimal; one in four reported being non-adherent to physical distancing and self-quarantining and one in three people reported non-adherence to getting tested when unwell. Modelling suggests that these levels of adherence are inadequate to contain SARS-CoV-2, in the absence of lockdown conditions and these must be effectively addressed if further waves are to be avoided. Despite the majority of the population being adherent to public health behaviour changes, those who were non-adherent to all three policies were more likely to be male, younger and live in major cities. Sub-optimal adherence in young people and males is likely driven by poor risk perception

and an inadequate concerns and beliefs in the importance of government policy, necessary to overcome the psychosocial, and economic costs of adherence. Communication strategies should focus on emphasising the personal risks of contracting COVID-19, and evoking empathy for society's most vulnerable. Support strategies need to minimise inconvenience and costs of policy adherence. Finally, sustained payments for those in quarantine and getting tested may be useful to remove barriers to adherence in groups that are financially vulnerable. Where these policies fail, poor risk perception and adherence will need to be mitigated through government punitive measures such as regulation and fines. Overall, our research emphasises the need to change community to behaviour to avoid further lockdowns and associated physical, social, and economic costs.

DATA AVAILABILITY STATEMENT

Data can be made available to approved researchers by contacting the corresponding author.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Monash University Human Research Ethics Committee (MUHREC Project ID: 24449). The patients/participants provided their written informed consent to participate in this study.

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Outdoor Physical Activity During the First Wave of the COVID-19 Pandemic. A Comparative Analysis of Government Restrictions in Italy, France, and Germany

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Introduction: Mandated restrictions on outdoor physical activity (PA) during the coronavirus pandemic disrupted the lifeworld of millions of people and led to a contradictory situation. On the one hand, PA was perceived as risky behaviour, as it might facilitate transmission of the virus. On the other hand, while taking precautions, regular PA was an important tool to promote the population's health during the lockdown.

Methods: This paper examines the differences in government restrictions on PA in France, Germany, and Italy during the first wave of the COVID-19 pandemic. We draw on techniques of qualitative content analysis and apply a critical theoretical framework to assess the countries' restrictions on PA.

Results: Our analysis shows that the restrictions on PA varied in the three countries, in all three countries. This variance is attributed both to differences in the timing and severity of the pandemic in the countries analysed, as well as to the divergence in the relationships between the countries' sport and health systems.

Conclusion: At the national level, the variance in restrictions on PA reflect the differences in the spread of the coronavirus and in the health systems' understanding of and approach to PA. The global scientific discourse on the pandemic represents a further key influencing factor. The management of the coronavirus pandemic has demonstrated that the extreme complexity of societies in terms of public health, politics, and the economy pose challenges and unsolvable contradictions.

Keywords: physical activity, COVID-19, sport, coronavirus pandemic, sociology, politics

HIGHLIGHTS

- Extraordinary interventions on population's lifeworld during the coronavirus pandemic.
- Different national approaches to PA restrictions.
- Emergence of distorted communications and forms of normative decisionism.

INTRODUCTION

On 13 April 2020, a couple of policemen chased, stopped, and fined a man who was jogging alone on an Italian beach with his dog. Numerous media outlets covered this "news" and the footage of this incident, which was filmed from a police helicopter, became an iconic clip. While this fact is *per se* irrelevant, it hyperbolically exemplifies the limitations the coronavirus pandemic imposed on physical activity (PA). This report analyses governments' decisions on PA during the first wave of the COVID-19 pandemic (February to April 2020) in France, Germany, and Italy. Guided by a Habermasian theoretical approach, the critical analysis of these communications lays at the core of this paper. According to recently published research agendas in the sociology of sport [1, 2], the pandemic was widely covered and discussed in both traditional and social media formats. From early on, this content also focused on the implications for sport, exercise, and PA. However, little is known about the present and future impact of the pandemic in this regard.

Over the last 20 years, the accumulation of scientific evidence confirms the benefits of leading an active physical life to maintain and protect one's overall health and well-being at all ages [3]. According to the WHO [4], today, physical inactivity and a sedentary lifestyle are the fourth leading cause of death worldwide [5] and continue to pose a major public health challenge. Moreover, sedentary lifestyles lead to physiological disorders, which in turn generate significant health care costs [6]. To prevent the spread of such diseases and to improve populations' health, PA promotion has been a key objective of global health strategies and policies for decades [7].

The coronavirus pandemic has radically changed the significance of PA for health, disrupting the PA routines of millions of people worldwide. The mandated restrictions imposed during the first wave of the pandemic significantly impacted PA related to work, commuting, sport and exercise, and has led to a contradictory situation. On the one hand, while not all forms of PA are equally risky, most types were at some point perceived as potentially aiding the spread of COVID-19. On the other hand, while taking precautions, PA remained an important tool to promote the population's health during the lockdown [8–10]. Previous pandemic crises caused serious public health consequences that were not only linked to the viral infection *per se*. The indirect consequences on community health have rarely been assessed, however. Studies on the severe acute respiratory syndrome (SARS) epidemic, for example, find that the community in Hong Kong responded by adopting healthier behaviours [11]. Some authors argue, however, that the coronavirus pandemic has the potential of

further intensifying physical inactivity and sedentary behaviour, which are entrenched in modern western society [12–14].

Despite the scientific consensus on the benefits of PA and the implementation of incentives to promote PA and the engagement of people in more active lifestyles, sedentary behaviour, and physical inactivity were on the rise before the outbreak of the pandemic, especially in high-income countries [15]. Many scholars, who have analysed public health data during the pandemic, stress that policymakers should not ignore modifiable lifestyle factors, such as dieting and PA [16], and mental health issues [17].

Against this background, the aim of this report is to analyse the differences in government restrictions on PA in France, Germany, and Italy during the first wave of the COVID-19 pandemic. The following sections describe our theoretical framework and methodological approach. We then present our results and conclude the paper with a discussion of our findings.

MATERIALS AND METHODS

Our view of the world *(Weltanschauung)* and theoretical approach is based on critical theory. Habermas [18] distinguishes between lifeworld and system. The former refers to the domain of shared understandings and a social horizon of everyday events, while the latter covers the domain of scientific and technical interests, guided by rational logic. PA's practise is a classic lifeworld domain that emerges from people's daily routines, sociocultural context and individual preferences. Controlling PA is one of those cases in which systemic logic penetrates—or rather colonises [19]—the symbolic reproduction of the lifeworld. Despite being rational by definition, systemic logics are manifold and may be divergent, since they pursue different goals.

The coronavirus pandemic has exacerbated the *steering problem*, making the system untenable because of internal contradictions that manifest themselves in the breakdown of normative structures [20]. Society evolved through a set of communicative actions that encompasses and structures the lifeworld of actors [21]. According to the *Theory of Communicative Action* [18], any act of communication must encompass four "validity claims": comprehensibility, sincerity, legitimacy, and truth. An ideal speech situation satisfies all requirements for mutual understanding. The communication of a political institution, in particular, should not violate the validity claims, should not manipulate or be systematically distorted. These crucial checkpoint criteria have been further developed in Habermas' work *Between Fact and Norms* [22]. He argues that norms are only valid if the recipient population accepts them and when this acceptance is based on the above-mentioned rational discourse [21]. Ideally, as many people as possible must be informed and involved in the public debate.

We used this theoretical framework to interpret a catalogue of selected government communications on PA in Italy, France, and Germany during the first wave of the COVID-19 pandemic. The early months of 2020 were amongst the most dramatic for Europe due to the novelty of the coronavirus, its severity and the high infection rate. As the leading authority in our

case countries, government-issued documents were analysed for our study. In contrast with a previously published review of international public health responses to the COVID-19 outbreak (23–25), our analytical strategy focuses on a small sample and applies the most similar stems design (26). Focusing on three conservative welfare states (27), which are highly populated, economically relevant, and geographically close, allows us to conduct an in-depth analysis and comparison.

The documents listed in **Table 1** are the primary source used for our sociological analysis. The review of these documents was loosely oriented around a qualitative content analysis, a systematic and flexible empirical method to examine the meaning behind data (28). Therefore, the content of the documents was selected, reduced and successively assigned to the categories of a coding system. Nevertheless, the interpretation of the material through the above-explained critical theoretical framework lies at the core of this study. However, we adapted part of the systematic approach to identify, analyse, compare, and criticise the narratives that lie at the core of our three case studies. This approach was followed to provide reliable insights to the question: "How did governments regulate PA practise during the coronavirus pandemic?"

RESULTS

The following sections briefly summarise—in chronological order and in a comparative perspective—the political decisions implemented in Italy, France, and Germany to regulate PA practise. The discussion critically evaluates the results.

Italy

All of the Italian Ministry of Health's National Health Plans have included the promotion of PA as one of the key public health goals. Additionally, over 14 million Italians of all ages claim that they regularly engage in sports (29). This suggests that the implementation of a strict lockdown, which in Europe was dubbed the "Italian lockdown," raised several issues.

The coronavirus began to spread across Italy at the end of January 2020. The highly populated region of Lombardy was hit particularly hard right from the beginning. On 31 January, the central government declared a state of emergency, mainly for economic reasons, pursuant to the law on civil contingencies (Civil Protection Code: CPC), which does not require parliamentary approbation. Such a declaration allows ministers to adopt exceptional measures in case of natural disasters, such as earthquakes and floods, but it is questionable whether limitations on civil liberties are justified for dealing with a pandemic. Despite this emergency declaration, no significant measures were introduced in the following weeks. On 23 February 2020, some municipalities in Lombardy were locked down and the Ministry of Health suspended all sport events in most parts of northern Italy.

On 1 March 2020, a decision of the Prime Minister confirmed the previous measures, which had ordered the closing of gyms, swimming pools, and other sport facilities in Lombardy and parts of the Emilia Region. Skiing was still permitted under the condition of "social distancing," and 3 days later, it was

decided that also "sport for all" activities (outdoor and indoor) were allowed only under this condition. On 8 March, Lombardy, Emilia, parts of the Veneto and the Piedmont regions were locked down, and all sport competitions were prohibited. The skiing areas in those regions were also closed, causing a tourist migration to the adjacent ski areas. On 20 March, the Ministry of Health ordered the closure of parks and green spaces, banning outdoor play and recreation. PA (but not jogging) was allowed within a 200-metre radius from home, always respecting the social distancing rules. On 26 April 2020, the Prime Minister announced that the parks and green spaces would reopen as of 4 May, and that sport for all—under the condition of social distancing, of course—would be permitted, and that professional athletes in some sport disciplines could resume training under given guidelines developed by the medical commission of the Italian Olympic Committee.

During the lockdown, Italians generally refrained from PA, limiting PA to either exercising at home or taking very short walks in close proximity to their homes (30). Some people even dared to engage in sport, at the risk of being reported to the police in a kind of *untorn* modern witch hunt.

France

To understand the situation in France, it must be framed within the context of recent government policies on health ["health democracy" (31)], and the fight against sedentary or inactive lifestyles: public health issues have been at the heart of the French government's agenda. Among the measures implemented in this regard, the health education programme "National Health and Nutrition Plan" (developed by the Agency for Health Food Safety in 2001) states that "people who regularly engage in PA have a lower risk of developing long-lasting diseases, regardless of their eating patterns and lifestyle habits" (32). Today, the 2019–2024 National Sport Health Strategy aims to reinforce this paradigm to fully recognise physical and sport activities as factors of physical and mental health, and to propose solutions that allow for such activities to be carried out under safe conditions.

The COVID-19 pandemic reached France on 24 January 2020, when the first case in Europe was confirmed in Bordeaux. However, only at noon on 17 March 2020, in the wake of the crisis in Italy, did France enter a confinement mechanism, which included the implementation of specific measures. The Ministerial Order of 14 March closed all sport facilities. The Decree of 16 March introduced the concept of self-certification, and the Decree and subsequently the Law of 23 March "normalised" the applicable regulations: people were allowed to take short walks, which were limited to 1 h daily within a maximum radius of one kilometre from home. Individuals could also engage in "basic PA," respecting the rules on social distancing, but any collective "sport activity" and proximity to others was forbidden. People could only take walks with those who lived in the same household; walking a pet was also allowed. A self-certification form was drawn up that differed from Italy's and included additional "reasons" for leaving one's home: individuals had the option of leaving their home to run or to take a walk, either alone, or with family members.

TABLE 1 | List of documents analysed.

Nation	Headline of the document	Issuing date
Italy[a]	Decision of the President of the Council of Ministers	26/04/2020
	Decision of the President of the Council of Ministers	10/04/2020
	Decision of the President of the Council of Ministers	01/04/2020
	Ministry of Health Ordinance	20/3/2020
	Decision of the President of the Council of Ministers	08/03/2020
	Decision of the President of the Council of Ministers	04/03/2020
	Decision of the President of the Council of Ministers	01/03/2020
	Decision of the President of the Council of Ministers	23/02/2020
	Ministry of Health Ordinance	23/02/2020
France	Prime Minister's speech introducing the deconfinement plan	28/04/2020
	Decree No. 220-423 supplementing Decree No. 220-293 prescribing the general measures against the COVID-19 epidemic	14/04/2020
	Decree No. 2020-293 prescribing the general measures against the COVID-19 epidemic	23/03/2020
	Emergency Law No. 2020-290 to mitigate the COVID-19 epidemic	23/03/2020
	Decree No. 2020-260 regulating travel in the context of the fight against the spread of the COVID-19 virus	16/03/2020
	Order for various measures to control the spread of the COVID-19 virus	14/03/2020
Germany	Telephonic conference of the Federal Chancellor and the heads of the federal states	15/04/2020
	Discussion between the Chancellor and the heads of the federal states	22/03/2020
	Agreement between the government and the heads of the federal states	16/03/2020
	Guidelines to slow the spread of the coronavirus	16/03/2020
	Discussion between the Chancellor and the heads of the federal states	12/03/2020

[a]In Italy the total number of dispositions, decisions and laws relating to COVID-19 up to 30 April 2020 amounted to 235, coming from various sources, including Parliament, the Council of Ministers' Presidency, Ministries, Agencies and ad hoc Commissioners. https://www.gazzettaufficiale.it/dettaglioArea/12 [only in Italian].

The Decree of 14 April 2020 extended the provisions of both the Decree and Law of 23 March. Toward the end of that month, on 28 April, the French Prime Minister gave a formal address about the country's re-opening strategy, explaining that it would be gradual, and that it would vary depending on the region. In the most affected ones (the "red zones"), parks would remain closed, but individual PA (excluding sport and collective PA) would be possible, even beyond the initially established one kilometre radius from home.

Germany

As is the case in many developed countries, the promotion of PA is an important objective of German health policies. Amongst other initiatives, the National Action Plan IN FORM (33), launched in 2008, explicitly draws on international health promotion guidelines and aims to provide "support for changes in behaviour through information and motivation, and the further development of health-promoting structures.

The first COVID-19 case was identified near Munich, Bavaria, on 27 January 2020. The Infection Protection Act (34) establishes that the state may restrict or temporarily suspend the basic rights of the population. During the coronavirus pandemic, fundamental rights such as personal freedom, freedom of assembly, and the right to bodily integrity were restricted. However, the restrictions mandated in Germany were moderately permissive compared to those imposed in other countries (for example, in Italy). Following a preparatory political meeting, the German government adopted official guidelines to contain the spread of COVID-19 on 16 March 2020. These guidelines

were supplemented and replaced by new and more restrictive measures on 22 March. Individual outdoor sport and PA were permitted throughout the lockdown period. The system of self-certification was not used in Germany. The initial measures imposed the closure of all sport facilities (public and private, outdoor, and indoor). On the same day, the federal government and the heads of the federal states agreed to an exceptionally uniform response to the coronavirus pandemic in Germany. The federal government and federal states jointly decided on 15 April to extend the applicable restrictions until 3 May, but at the same time, allowed small businesses to re-open and gradually re-opened educational facilities and religious buildings. The loosening of these general restrictions was applied with minor deviations in the German states. In Rhineland-Palatinate, for example, some sport facilities were re-opened. This, and specifically the question about the requirement to wear protective masks, reignited the debate on the need for decision-making at the central level.

DISCUSSION

The coronavirus pandemic dramatically intensified government intervention in the lifeworld of populations (2). Heeding the advice of the medical-scientific domain, national, regional, and local political levels implemented decisions, on occasion also using coercive methods. Different levels of PA restrictions identified in the three countries during the first wave of the pandemic reflect both the differences in timing and severity of the pandemic in the countries analysed, but the restrictions hinged

TABLE 2 | Summary of results[a].

Country	First reported infection	First PA restriction	Loosening of PA restrictions	Intensity of PA restriction	Coupling of health-sport systems	Mortality excess (first wave)
Italy	31-01-2020	23-2-2020	18-05-2020	High	Moderate	High
France	24-01-2020	14-03-2020	28-04-2020	Moderate	Strict	Moderate
Germany	27-01-2020	16-03-2020	15-04-2020	Moderate	Strict	Low

[a]The "intensity", "coupling" and "mortality" indicators have no analytical value. They only provide a synopsis of the report. The "mortality excess wave" indicator measures the deviation in mortality from the expected level. The table does not consider absolute values and compares instead the data reported among the three countries. Information based on Eurostat data: https://ec.europa.eu/eurostat/databrowser/view/DEMO_MEXRT__custom_342641/bookmark/table?lang=en&bookmarkId=7c411664-aa81-460c-aa40-22472512fe8b.

on the same rational logic underlying the global epidemiological discourse (**Table 2**).

Divergent relationships between the sport and health systems may also be an explanation for the differences. In France and Germany, for example, PA is treated as a key component of the health system and is perceived as a protective factor. In Italy, PA was ultimately not considered crucial and, paradoxically, represented an element of potential corrosion of social consensus on the lockdown.

From a Habermasian point of view, the pandemic poses major challenges (35) in terms of carrying out swift and relevant interventions in the context of complex and differentiated societies. Due to the novelty of the situation and structural problems of democratic decision-making procedures, the differences were also attributable to partly divergent goals in public health, politics, and the economy. In the best-case scenario, broad consensus on the regulation of liberties and freedom would have been reached based on rational discourse. Instead, the public sphere, in the sense of an open, non-coerced debate, seems to have followed the path illustrated by Habermas in the sixties: a progressive trivialisation that seems to severely hamper the formation of public opinion, leading again to the so called "refeudalisation" of reality, impeding the building of consensus and, consequently, leading to forms of normative decisionism that deviate from ideal communications, are not fully transparent and only partially admissible in the reality of Western democracies (36). In the case of Italy, for instance, the huge number of "Decisions of the President of the Ministers Council"—normally a rarely used normative instrument—was employed as a means of restricting personal freedoms, with very limited involvement of Parliament, leading to intense criticism, also from public law scholars.[1]

The problem, in particular, of truthfulness emerges in relation to the rapid implementation of political decisions based on

scientific knowledge. In an ideal speech situation, all arguments presented in the discussion should be factually correct, verifiable, and scientifically based. Yet several issues affected the truth of scientific rationality beyond the justifications of the approach to contain the pandemic. From an epistemological perspective (37), scientific knowledge on COVID-19 is still partly conjectural or hypothetical since the virus and its transmission are new to the scientific community. Consequently, scientific assumptions were decidedly followed, even though they were far from being conclusively proven and could be and were falsified in the short-term future. Moreover, determining the indirect impacts of the measures adopted was excessively complex and may only emerge in the mid to long term. This certainly applies to the restrictions on PA, whose risk assumptions did not rely on solid scientific evidence.

Aside from these inherent limitations, scientific knowledge is sometimes used misleadingly to implement political decisions. This was particularly evident in the context of the strict "Italian lockdown." Despite the low risk for spreading the virus, individual outdoor running was completely prohibited in Italy. The rationale for this was the concern that too many people would have used outdoor running as a way to evade the lockdown restrictions. In other words, scientific evidence was misrepresented to support strategic aims. The prohibition of outdoor PA is an extraordinary interference of the system on the population's lifeworld. Because of the state of emergency, and with the legitimation of the medical-scientific domain, the political system was successful in exerting its power. Indeed, leveraging on medical, moral and patriotic argumentations, the restrictions during the first wave of the COVID-19 pandemic were met with less resistance by the population in the three countries covered in our study. Protests against the restrictions arose during the second wave and were associated with the prevalence of "pandemic fatigue" in the general population rather than with the severity of the restrictions (38).

Despite these critical considerations of the trade-offs between the benefits and detriments associated with the restrictions on PA, the dramatic and rapidly evolving course of the pandemic in the period considered here was acknowledged as being perhaps the most serious challenge Europe has faced since the Second World War. In this context, policymakers may have not taken adequate heed of the risks associated with the lockdown, but they did not take the decision lightly, and had to juggle the different risks. In hyper-complex societies

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[1]Among the most relevant articles, see [in Italian]: Azzariti, G. (2020). I limiti costituzionali della situazione d'emergenza provocata dal Covid-19. Questione Giustizia, 27; Massa Pinto, I. (2020). La tremendissima lezione del Covid-19 (anche) ai giuristi. Fiat iustitia et pereat mundus oppure Fiat iustitia ne pereat mundus?, Questione giustizia, 18; Civinini, M. G., & Scarselli, G. (2020). Emergenza sanitaria. Dubbi di costituzionalità di un giudice e di un avvocato. Questione Giustizia, 14. [in English]: Simoni A. (2020), Populist legal strategies and enforcement discretion in Italy in the COVID-19 emergency, in Rister de Sousa Lima et al. (eds.), Covid-19 e os impactos no direito: Mercado, Estado, Trabalho, Família, Contratos e Cidadania, Almedina, Brazil.

and in critical situations, political communication cannot be ideal. Nonetheless, some recommendations can be formulated. Specifically, public communication needs to be separated from regulatory activity. The former must be disseminated unambiguously, promptly and adequately with regard to the situation at hand. The rapid dissemination of information through different media (e.g., social media, television, or government websites) may have a negative impact on the information's reception. Furthermore, regulatory activity must take account of the temporal dimension of the emergency through the possible minimal use of extraordinary regulatory instruments. The habitual (democratic and/or federal) decision processes through the entrusted political bodies should be restored as soon as the emergency permits.

To conclude, the coronavirus pandemic is an ongoing critical event, which indubitably needs to be further analysed and reflected upon based on different perspectives. Critical sociological research on health and PA policies may contribute to reflections on and to safeguarding the rationality of the political discourse (21). While pursuing this aim, this report constitutes only a first and explorative step in this direction. Amongst other limitations, the available data do not permit an in-depth discussion on other important factors which may have also played an influential role in the governments' choices. This, as well as other aspects related to the question "How will sport, exercise and PA change in the aftermath of the pandemic?" represent interesting phenomena for sociological analysis of PA, and we encourage inquiries into these issues in the future.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

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A Citywide 'Virus Testing': Chinese Government's Response to Preventing and Controlling the Second Outbreak of SARS-CoV-2

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Containing the spread of SARS-CoV-2 is a daunting challenge globally. China, as well as a handful of other countries, has, for the most part, contained it by implementing strict policies. Wuhan's citywide virus-testing program presents a way forward in preventing and controlling the uncertainty, anxiety, instability and complexity it faces over the outbreak of SARS-CoV-2. Inarguably, the health crisis requires time-tested strategies and tactics for coordinating governments' and social entities' response to the health crisis, with a goal toward having and ensuring sustained effectiveness. Because of a possible recurrence of SARS-CoV-2 in Wuhan, the Prevention and Control Headquarters of Wuhan on COVID-19 launched a massive virus testing of Wuhan's 11 million residents; it was completed within 10 days. In light of this unprecedented mass testing, this study applies the situational crisis communication theory to analyze this massive virus-testing process and the mechanisms involved to contain SARS-CoV-2 in Wuhan. While many countries still have partial lockdowns, the second outbreak in Wuhan was an indication of what awaited all SARS-CoV-2-stricken countries post-lockdowns and after community restrictions had been lifted. Therefore, the recently implemented Wuhan control mechanism (in cities, districts and townships) may become a hortatory guide to other world regions as they contend with and consider appropriate measures to control the spread of SARS-CoV-2 and to ensure public safety.

Keywords: control mechanism, crisis management, massive virus testing, SARS-CoV-2, Wuhan

INTRODUCTION

The evolving SARS-CoV-2 crisis presents a daunting challenge and a continuing conundrum to the global community (1–6). During the past two decades, the world responded to a series of virulent health crises: SARS, MERS, H1N1, Zika and, recently, SARS-CoV-2, which, to date, has affected more than 190 countries and territories, resulting in more than 170 million confirmed cases and 3.5 million deaths (7). This enormous devastation is mainly due to human behavior and to the response of local and state governments worldwide (8). The coronavirus disease (COVID-19) is mainly caused by a virus named severe acute respiratory

syndrome coronavirus 2 (SARS-CoV-2). COVID-19 was so branded officially by the World Health Organization (WHO) on February 11, 2020. Institutions worldwide are continually monitoring the trajectories of coronaviruses and their tendency to trigger new outbreaks. Similarly, governments across the globe have persistently introduced mechanisms and management strategies to cope with a variety of national challenges—from natural disasters to environmental issues to epidemics to pandemics. An effective response has always been a challenge to central, provincial and local governments, as they strive to enhance their public credibility during such emergencies. The degree of complexity and seriousness varies from crisis to crisis and the social governance of governments is expectedly stretched. Generally, an early response through a well-established prevention-and-control mechanism can make a difference in effectively controlling and resolving a crisis.

The Wuhan government has used test-trace-isolation-treatment approach, before going for the citywide mass testing. On May 7, 2020, a male person from Sanmin Community, Changqing Street, Dongxihu District, tested positive for the nucleic acid test. On May 9, after reexamination, the antibody result was positive, and was identified by experts as a confirmed case of SARS-CoV-2. The virus-testing result of his close contact, his wife, was also positive but asymptomatic; their daughter's was negative and she presented no symptoms. There were 20 confirmed cases in the community where the patient lived. Public-health experts analyzed various factors and found that the cause was mainly from past community infections (9). Since the case's positive result was known on May 7, the national and provincial disease control experts immediately conducted epidemiological investigations and administered virus tests on community residents. Five asymptomatic cases were recorded. By adopting the situational crisis communication management strategy, the leaders of the provincial, municipal, and district governments attached great importance to the epidemic and quickly adopted several prevention and control measures. First, they implemented centralized isolation and nucleic acid testing, for key populations and close contacts, and carried out traditional Chinese-medicine intervention. Second, they decided to lock down the community while increasing environmental governance and disinfection, as this strategy is considered one of the effective ones (10). Third, they made every effort to strengthen treatment and transfer all asymptomatic cases to hospitals for medical observation and combined Chinese and Western medical treatment.

The six new confirmed cases of SARS-CoV-2 in Sanmin ended Hubei province's status of having no new confirmed cases in 35 consecutive days. To prevent a possible outbreak and to screen for potential asymptomatic infections in communities such as Sanmin, the Prevention and Control Headquarters of Wuhan on COVID-19 took prompt actions, guided by the possibility of a second surge in SARS-CoV-2 cases. An "Emergency Notice on Launching the virus testing of SARS-CoV-2 for the Entire City" was issued May 11 to tackle the possible threat and to target residents for citywide virus testing within 10 days. The ultimate objective of this massive scale of testing was to target untested residents from both dense and remote areas of Wuhan. In light

of this initiative, the Wuhan Municipal Government convened a phalanx of experts for frequent coordination briefings during the mass testing and screening of asymptomatic infected people in Wuhan. Further, it was decided that the scope of virus assay would be expanded. Virus testing for all citizens would be carried out and a comprehensive screening of asymptomatic infected people would also be made, based on the previous three million virus assays that were carried out during the first wave of the pandemic. For such an operation to become realizable, funds were disbursed by both the municipal and district finance in a 1:1 proportion (11). Currently, the demographic data indicate that the resident population of Wuhan is 10.89 million (12). Based on that calculation, there are still about 7.89 million people waiting to be tested. During the first wave of the outbreak, three million were tested; they were excluded from the second-wave virus testing. The Hubei provincial government immediately made 53 virus-testing institutions and 211 virus-testing sites in Wuhan available to residents, for an average daily detection capacity of 46,000 people (13). The 10-day timeframe implied that a daily average detection capacity of about 80,000 people would be needed. Ten additional virus-assay institutions for COVID-19 were established (14) to meet the daily detection capacity. Thus, the Municipal Health Commission applied all of its resources in its effort to reach the set target, thereby ensuring its strategic effectiveness in containing the second surge of SARS-CoV-2 in Wuhan.

In view of the still-severe situation of global epidemic prevention and control, how does the Wuhan Municipal Government assuage public concerns and sensitivities, engage in credible publicity and in information dissemination on virus testing, and encourage voluntarily participation in the testing? How do the local government's persuasive messages ensure that the work can be completed successfully in the shortest possible time? What is the effect of hierarchical prevention and control and social linkage emergency management mode adopted by local governments in response to public-health emergencies? How and why can Chinese local governments achieve the prevention and control of the pandemic through such top-down social mobilization? The answers to those questions underpin the objectives of this article, in hopes of providing a government-level point of reference on extant research literature on SARS-CoV-2 prevention and control. The rest of this article is organized into five main sections: (a) review of the literature, followed by our two-pronged theoretical framework; (b) methods and strategies; (c) results; (d) discussion; and (e) implications of the theoretical framework for governments' pandemic response. The conclusion section asserts the public-health resolve of the Wuhan government to protect its citizens from the devastating effects of an impending SARS-CoV-2.

LITERATURE REVIEW

The extant research on SARS-CoV-2 was conducted primarily in fields such as medical science, public health, informatics, and communication, but rarely from the perspective of public-health administration and its response to unconventional and

unprecedented public-health emergencies. Even though studies have been conducted from a crisis-management perspective, they focused on the early phase of SARS-CoV-2 outbreak (15, 16). The present study, however, focuses on the upcoming crisis of SARS-CoV-2. Research on prevention and control mechanisms of local governments' responses to epidemics in China and on their specific response to them is also minuscule. The current pandemic still wreaks havoc in communities, urban and rural, making the rationale for this study on the emergency-management response of local governments in China a point of departure for other governments, even as this study also provides comparative materials on COVID-19 prevention and control for public-health academics.

Studies on COVID-19 in General and Virus-Testing Approaches

Research on COVID-19 can be presented in three broad categories: (a) research published by medical professionals and experts to highlight its genetic makeup, pathophysiological manifestations, associated signs and symptoms, its incubation process and complications (17–19); (b) research that focuses on the preparedness and risk management at the organizational level, specifically addressing the prevention and control measures for frontline health professionals (20–22); and (c) reviews that highlight the general impact of COVID-19 on countries' socioeconomic environment and their responses to the pandemic (23–26).

Abrams and Greenhawt (26) noted that effective risk communication could keep patients and the public well-informed. Zhou, Su and Pei et al. (27) noted that the geographic information system has played a crucial role in fighting against the pandemic by tracking the confirmed cases and providing information on risk and prevention. The fast information-dissemination system provided quick information on safety and prevention measures, besides lockdowns.

Virus testing, a research category in its own right, offers more sensitive and early detection of SARS-CoV-2. The extant literature identified a variety of options for fast, cost-effective and sensitive virus testing and virus testing was suggested as the most reliable approach for early assay of SARS-CoV-2 (26–28). Esbin, Whitney, Chong et al. (28) categorized testing methods into two: viral and serological. In the former, the RNA virus collected from a patient's throat or nasal passage is directly examined, whereas the serological test detects antibodies in the patient's serum (29). Virus testing is most effective in early assay of SARS-CoV-2; hence, it explains the massive virus testing of Wuhan residents to contain the further spread of a second-wave of the epidemic in the aftermath of diagnosing six new cases. Before we present the materials and method of this article, we shall provide highlights of its theoretical underpinnings.

The Theoretical Framework of Crisis Management and Coordination

Based on extant knowledge of the origins of SARS-CoV-2, we conclude that it falls squarely in Ulmer, Sellnow and Seeger's (30) category of an unintentional crisis or Coombs's accidental crisis, both of which "tend to be outside the realm of intentional human provocation" (10, 31). The novel coronavirus was, as far as current clinical evidence suggests, not the doing of any government or of any agency. As Pratt (31) notes, "Crisis communication managers have at their disposal a number of theories that can provide the guiding light to what such response *should* be" (10). Therefore, Coombs's situational crisis communication theory (SCCT) (32, 33) provides a road map for Wuhan government's provincial response to SARS-CoV-2. Cast against that backdrop, SCCT is guided by answers to a two-pronged question: (a) How do Hubei residents and the world at large respond to the ensuing health crisis? (b) What are the best response strategies the Wuhan local government can adopt to restore public confidence and its public reputation? The audience-centered theory is grounded in attribution theory; therefore, the more the cause of the crisis is viewed publicly as beyond the control of Wuhan local government, the lower the attribution of responsibility to the government.

McConnell (34) rightly explained the success and failure of crisis management by suggesting that "crisis management initiative is successful only if it follows pre-anticipated and/or relevant processes and involves the taking of decisions which have the effect of minimizing loss of life/damage, restoring order and achieving political goals, while attracting universal or near universal support and/no or virtually no opposition." Crisis management is fraught with uncertainty, instability and complexity, thus requiring a specific approach to ensuring coordination between government institutions and social entities and increasing the efficiency of the governance system and of crisis-management performance (35). In that context, Christensen and Ma (35) noted categorically that "without strong coordination capacity to mobilize various entities to respond concertedly to emergencies, crisis management can neither succeed nor sustained." In other words, coordination is key to bringing all the interdependent actors into active interaction to respond effectively to a crisis.

This study also subscribes to Christensen and Ma's (35) perspective on coordination, which was specifically developed in the Chinese context. They presented coping strategies in crisis management for analyzing measures taken by the Wuhan government to contain further spread, by introducing citywide virus testing of all Wuhan residents. The framework of coordination, vertical and horizontal coordination in crisis management posits that, in the upper-right quadrant, both horizontal and vertical coordination mechanisms are in high gear to respond this ongoing health crisis. Based on the Christensen and Ma's (35) theoretical framework, we may induce that the relevant ministries may simultaneously coordinate with local government institutions while responding to the second-wave of SARS-CoV-2. Indeed, such a massive move, to test 6–8 million people in 10 days, requires a well-established joint coordination mechanism among different local government and social institutions to make their crisis management efforts a success.

METHODS AND STRATEGIES

Specific Implementation of Virus Testing in Wuhan

Organizational Structure and Control Mechanism

According to the requirements of the *Emergency Notice* issued by the Prevention and Control Headquarters of Wuhan on COVID-19, to cover the entire city within the 10-day timeframe, the virus assay was implemented in phases, districtwide. The first step required the district government to normalize the requirements of epidemic prevention and control according to the population scale, and to formulate the whole virus screening plan in combination with the actual situation of the district. That means there is a strong need to develop active and close coordination among different local institutions and administrative units to implement the virus-testing plan effectively. It requires an immediate mobilization of relevant resources such as reagents, equipment and trained medical and para-medical staff to ensure the maximum testing of the residents to meet the target timeframe.

The aim of this article is to analyze the implementation of Wuhan's citywide virus-testing program. But the impact of the pandemic, restrictions on local movements and 14-day isolation measures issued by governments across China translate into the authors not being able to immerse themselves in Wuhan government departments and in specific communities to conduct necessary field investigations. Therefore, there is a palpable lack of firsthand data. Because this study is based entirely on official government reports, it does not have a comprehensive methodology. For example, it lacks key data on the number of staff involved in the large-scale virus testing, the intensive training of staff, and the specific logistical support measures of governments. The authors developed a control mechanism chart by applying the coordination theoretical framework to work at both vertical and horizontal dimensions to ensure the effectiveness of the crisis management (**Figure 1**).

Figure 1 shows a clear trajectory of the Wuhan Municipal Government, which implemented a citywide virus testing to reduce a further spread of the epidemic and eliminate potential risks. The local government first builds a broad social consensus and makes SARS-CoV-2 prevention and controls its highest priority, then sets up the epidemic prevention and control headquarters and, in sequential levels, implements it in the corresponding district, township, street or community management departments. This shows that at the government level, the society has moved from a normal state to a state of emergency. In addition to working through the organizational structure and enabling the rapid start and high-speed operation of information and resources, the government also makes it possible to maximize social mobilization and carry out "Movement Governance." In short, under this kind of mechanism, it is very beneficial to focus attention, work through conventions, concentrate resources to execute the prevention-and-control model of "Holistic Government," and conduct blanket virus testing. The

government's organizational setup for addressing pandemics leads to two structural observations.

First, from a vertical perspective, under a strong accountability system, epidemic prevention and control have become the main indicators for evaluating the effectiveness of local government governance. This figure can, therefore, facilitate the implementation flow of government orders from top to bottom, ensuring grassroots inclusivity in the process, and providing a mechanism guarantee for local officials to mobilize various resources to the greatest extent to carry out prevention and control. Second, from a horizontal perspective, the implementation of citywide virus testing in Wuhan, a high-risk area, not only requires government departments not only to deploy resources, but also requires of them extensive mobilization of enterprises, nongovernmental organizations, and the engagement of the public in participating fully in the process of epidemic management. It must be noted that the unified thinking and collectivist values in traditional Chinese culture have helped reduce the social cost of epidemic control and coordination. The Chinese tend to put national interest first and are willing to give up part of their personal interests, rights, or spaces so that local governments confront less resistance in implementing a virus-testing policy, a subject to which we shall now direct our attention.

Administrative Divisions and Testing Focus

Under the joint leadership of the street and community party organizations, all communities, together with institutions within their jurisdiction, such as the residents committee, the owners committee, the property management company, the community health service center, the community police office, volunteer groups and families, jointly assisted in the large-scale testing, forming a multiparty collaborative governance mechanism at the grassroots level. The district government needed to further clarify the basic situation (population base, number of streets, number of communities and their locations), organizations, time arrangement (specific to the sampling time of streets and communities) and other precautions. Wuhan includes 17 administrative districts (functional areas). Each district has 156 subdistrict offices, one town and three townships, 1,337 community committees and 1,814 village committees among them (36), as presented in **Table 1**.

In sum, new confirmed cases districtwide, as of May 14, 2020 (that is, before the start of large-scale testing), totaled 50,339 in Wuhan. They ranged from 483 cases in Donghu Scenic Zone to 6,563 in Jiang'an District to 7,551 in Wuchang District (37). The focus was fourfold: (a) identifying the detection range, (b) targeting the priority-detection population, (c) identifying further the number of asymptomatic infections, and (d) implementing effective controls. More emphasis was placed on priority detection groups: old urban areas, communities with dense external tenants, urban-rural junctions and residential areas around large markets. In places where positive or asymptomatic infections were found, the scope of nucleic acid testing was expanded to improve its efficiency. However, it must

FIGURE 1 | Framing of control and coordination mechanism by applying the situational crisis communication theory to conduct virus testing in Wuhan.
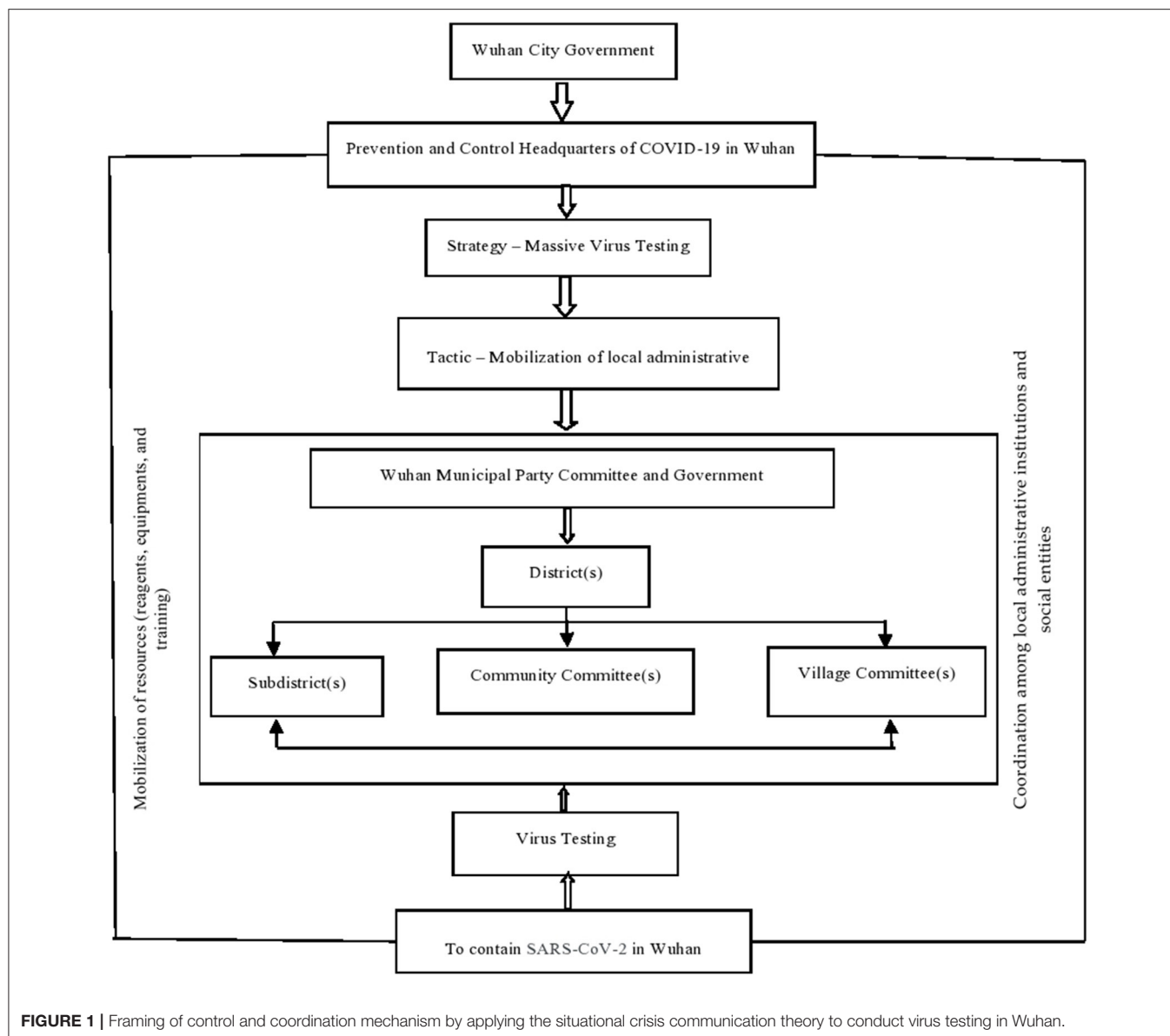
be noted that children younger than 6 years were excluded, even though their numbers were not released.

Using Jiang'an District as an example, by widely depending on the advice of field and community representatives on epidemic prevention and control, the district headquarters issued on May 12 the "Notice on Deepening the Party Construction and Leading the Grassroots Governance for an Effective Approach to Community Epidemic Prevention and Control." This notice implied that the degree of community epidemic prevention and control would be improved comprehensively through strengthening the subdistrict working committee and community party committee, establishing temporary party branch as check-points, implementing the community (grid) party organization, and enriching the building party group and party-member central household, while reducing significantly

ground-level inanition. Moreover, the normalization guarantee mechanism would be adhered to, and efforts would be made to establish corresponding normal guarantee mechanism from the aspects of human resources, material resources, systems and incentives (38).

THE TESTING PROCESS: ANALYSIS IN WUHAN

Nucleic Acid Test Rationale and Laboratory Practice

The Nucleic Acid Test (NAT) is regarded as an effective and immediate method of detecting the SARS-CoV-2 virus because of its high degree of sensitivity and specificity. The rationale behind

TABLE 1 | Administrative divisions, resident population and grassroots units of Wuhan.

District	Resident population (10,000 people)	Subdistrict offices (unit)	Community committees (unit)	Village committees (unit)	Town governments (unit)	Township governments (unit)
Whole City	1089.29	156	1,337	1,814	1	3
Jiang'an	96.24	16	142	14		
Jianghan	72.96	13	108	0		
Qiaokou	86.85	11	127	1		
Hanyang	65.27	11	118	0		
Wuchang	125.86	14	140	1		
Qingshan	52.88	10	83	12		
Hongshan	117.16	13	161	3		1
Caidian	45.93	11	46	283		1
Jiangxia	70.51	15	66	268		
Huangpi	98.83	15	77	589		1
Xinzhou	90.21	12	67	546	1	
Dongxihu	56.25	11	65	0		
Hanan	13.55	4	15	29		
Wuhan economic and technological development zone	27.57		37	21		
East lake high-tech development zone	56.14		68	26		
East lake ecotourism scenic zone	8.46		16	1		
Wuhan chemical industry park	4.62		1	20		

Wuhan Statistical Yearbook, 2018, Wuhan Bureau of Statistics.

this test is that nucleic acids, which are essential biomolecules, are present in large amount in all living things. The nucleic acids or bio-polymers are commonly known as the DNA or RNA of a molecule and encode all the genetic information of a particular organism. The nucleic acid test is a technique for detecting the genomic sequence, which helps to identify different species, usually pathogenic microorganisms, such as bacteria or viruses in blood. NAT works by amplifying those genetic strands through a process known as polymerase chain reaction (PCR) which are then paired with the RNA specific to the corona virus for detection. By identifying the genetic components rather than detection of antigens or antibodies from blood samples that require time to appear, health-care providers have an upper hand in early diagnosis of COVID-19. The sample from which the genetic materials are extracted is taken from nasopharyngeal swab or sputum of patients being tested. Those samples have to be handled with maximum care to avoid any contamination of the laboratory staffs by observing very strict sterilization protocols and wearing protective equipment. In fact, for molecular analysis of the pathogen to take place, it is important that the inactivation process of the molecule guarantees a complete loss of the infectiousness of the virus, but at the same time, protects the integrity of the nucleic acids. Only the inactivated samples are safe to be manipulated for testing. Inactivation of the sample involves using extreme *in-vitro* denaturing conditions, mostly in heat, to disrupt the viral envelope and eliminate cellular nucleases. However, the structure of the RNA is preserved for subsequent analyses. Those samples are kept in a highly decontaminated area, under biosafety level 3

standards for diagnosis and later disposed of in sanitary landfills after strict sterilization.

For instance, in a particular virus-detection laboratory in Wuhan constructed in accordance with P2 standards and with a biosafety level 3, and which is also a designated government COVID-19 test base in Hubei province, the samples that came for inspection were packed in a foam box. The sample delivery point was sprayed regularly with alcohol; the foam box was then sent to the inactivated room through a transfer window. The inactivation process prevented the spread of the disease. The technician unpacked the box in a biological safety cabinet in which each sample was handled separately for safety reasons. Samples were then sent to the information review room for accuracy check, using a barcode, and then sealed in a Ziploc bag to reduced probability of contamination. Strict safety management was also reflected during trans-shipment as the outer packaging of the sample was wrapped in an additional plastic container in order to keep the sample fix during transportation. Further, the laboratory staff responsible for the handling of those samples would use a 75% medical alcohol to sterilize both the handle and platform of the transfer window before putting samples in the window.

The testing laboratories operate under strict adherence to guidelines issued by the National Health Commission for biological safety protection and experimental operation. According to the "Laboratory Testing Technical Guidelines of COVID-19 (Second Edition)" and "SARS-CoV-2 Laboratory Biosafety Guidelines (Second Edition)," those laboratories operate using real-time fluorescent quantitative RT-PCR (Reverse transcription-PCR) technology for RNA extraction and

amplification detection. The coronavirus SARS-CoV-2 genome is made up of a leader sequence, ORF1ab which encodes proteins for RNA replication and genes both for non-structural proteins (nps) and structural proteins. The SARS-CoV-2, similar to other beta-coronaviruses, encodes four major structural proteins; namely, the spike (S), envelope (E), membrane protein (M), and nucleoprotein (N). According to the instructions of the nucleic acid kit, the three targets in the virus, namely, the envelope (E), RNA dependent RNA polymerase (RdRP) and the nucleoplasmid (N) genes, are taken as the test objects, and Ct/Cq = 43 as the baseline for result interpretation (negative, single positive, positive): when Ct/Cq ≤ 43 and the amplification curve is typical S type, it is positive.

The Key Nodes of Virus Testing in Wuhan
Qualifications of Nucleic Acid-Testing Institutions and Inspectors

According to the *Laboratory Testing Technical Guidelines on SARS-CoV-2* (Fifth Edition), *Medical Institutions Clinical Gene Amplification Management Measures, Pathogenic Microbial Laboratory Biosafety Management Regulations* and other policy documents, through qualification review and on-site assessment, only qualified professional institutions approved by the provincial headquarters of COVID-19 Epidemic Prevention and Control can carry out testing. Since the SARS-CoV-2 is managed in accordance with the second category of pathogenic microorganisms, the approved institutions have been registered for biosafety on the second-level laboratory and have a reserve of biosafety on third-level laboratory protective equipment. For inspectors, they must obtain a biosafety training certificate for pathogenic microorganisms' laboratory at the municipal level or above, a certificate for clinical gene amplification testing technicians, and a SARS-CoV-2 virus testing.

Guarantee of Virus-Sampling Quality

To guarantee the quality of on-site sampling, community-health service centers (township hospitals) and hospitals would be in charge of the sampling work. It was determined by the city government that technical training would be provided to the assistance personnel from these units on how to conduct population sampling. After mastering that technique, personnel will learn the operation of technical instruments required for getting samples, the standard collection methods of nasopharyngeal swab and throat swabs, a sampling team would be organized to sample from each screening unit. Generally, through the method of mixed sample pool (5–10 samples in a group), the slight loss of "specificity" is ignored, and its high "sensitivity" can be used to screen asymptomatic infections on a large scale and greatly improve the testing speed. The municipal and district governments also set up several technical guidance and quality control working groups to ensure the sample quality and testing quality, and to safeguard the precision and reliability of testing results through on-site guidance, supervision and inspection.

Registration Form for Testing the People

A registration form was designed to ensure that the tests carried out would be ethically acceptable by the people. Community workers would then send out the notice of free virus screening for all residents online and offline, then organize residents' registration by WeChat group, telephone and household entry, and communicate to them where arrangements for detection points in the community would be made. The community staffs and volunteers allowed the people to register through three channels: (a) advertisements in WeChat grid groups, and build up a sequence for registration; (b) calls to residents separated from their families and live in rented houses to check and explain the intentions behind detection; (c) registrations of the elderly, who are not familiar with the use of smart phones or WeChat and who are disabled or have limited mobility.

Strategies for On-Site Sampling

The community was taken as a unit and then divided into districts and buildings to prevent crowding at one place on a short notice. Through micro neighborhood applet, community broadcasting and other means of relaying information, people were reminded about good personal protective measures that they needed to follow. Sampling points in the open area of the community were selected in a manner consistent with ensuring proper sanitation practices like using sanitizers and hand wash, and having proper aeration in public areas. Temperature monitoring points were also set up at the entrance, and special personnel arranged to help residents keep social distance by constantly informing them about its importance. The sampling staffs were also well-protected and made every effort to remind the residents to wear masks (wear one, prepare one). After taking a sample, the gloves would be changed or disinfected. Additional staffs and volunteers were deployed at each sampling point to guide the site protection, handle accidents promptly and ensure the orderly development of the virus testing.

Nucleic Acid-Testing Technique and Quality Assurance

The nucleic-acid testing of RT-PCR is the main method for the diagnosis of COVID-19. The SARS-CoV-2 nucleic acid gene is used to design primers for target detection. The nucleic acid detection process of SARS-CoV-2 includes sample collection, storage, transportation, sample pre-processing, nucleic acid extraction, and nucleic acid amplification and detection and result interpretation. To confirm that a case is positive, the test results of at least 2 targets (ORF1ab/N/E) of the SARS-CoV-2 in the same specimen must be positive. In addition, negative results need to exclude factors that may cause false negatives. In order to achieve the purpose of early screening, diversion of suspected cases, timely isolation and treatment of patients, in addition to pathogenic testing and diagnosis, auxiliary diagnosis can be made based on clinical symptoms and CT images.

Test Results Query and Privacy Protection

Generally, virus testing results are collected by a special system for storage 24 h after assay. The system is strictly independent, with highly secured login access. The user input is closely

monitored to ensure that the personal information security of the inspected citizens is valid and well-protected. If a test result is positive, the relevant department personnel will contact the patient immediately to conduct standardized treatment according to diagnosis and control requirements. If the patient does not receive the relevant notice, the test result will be automatically deemed negative. In addition, residents who have participated in the centralized virus testing can enter the WeChat applet of "Wuhan against the epidemic" and view the result under the "Hubei health code"; or log in the "Official WeChat of health Wuhan" applet by mobile phone and click "Virus result query" to complete the personal identity information and then query the nucleic acid test results. Virus-testing results have indicated, generally, four types of contents to protect the personal privacy: (a) the name of the sample sending organization; (b) sampling time; (c) sample code; and (d) the test results to ensure the security of the personal information of the residents.

RESULTS

Effectiveness of the Massive Virus Testing

The main target of the large-scale campaign in Wuhan is focused on permanent and temporary residents who have not been previously subjected to such detections. And the purpose is to find the maximum number of asymptomatic infected people so as to achieve the goal of blocking the spread of the virus from any probable sources. This enables early detection and treatment of confirmed cases, and early isolation of asymptomatic infections, resulting in a safe and healthy environment conducive to the resumption of work and school.

Numbers and Characteristics of Asymptomatic Infections

According to statistics from Wuhan Health Commission, a total of 665 asymptomatic infections were found in Wuhan since it was "unlocked" on April 8. Some 2,508 close contacts were tracked, of which two were asymptomatic infections; the ratio was 0.8‰, and noconfirmed case was found. As of May 13, in addition to the six confirmed cases in Sanmin, there were 659 asymptomatic infections in total. Based on serological test results, personal trajectories, and previous symptoms of asymptomatic infections, Wuhan CDC determined that 559 of them had previous infections, accounting for 84.8%, while 97 were hidden infections, accounting for 14.7%; three were unclear (39). From the daily epidemic prevention and control dynamics of Wuhan Municipal Health Commission, since the citywide virus assay was officially launched on May 15, Wuhan's single-day capacity of virus assay has been continuously improved until May 23, 2020 (**Table 2**). Through May 23, the government released daily data while on May 24, in accordance with final data released by the government, more than nine million samples and more than 6.5 million inspections had been completed. It must be noted here that the authors could not find single-day data for May 24. Through May 23, 206 new asymptomatic infections were identified while the final released data showed 218 asymptomatic

infections. The detection rate was lower than 0.3 cases per 10,000 people (40).

It can be inferred from the above data that, because the city undertook the virus assay, as **Table 2** shows, asymptomatic infections increased daily. According to the analysis of experts (e.g., Zijian Feng, Deputy Director of China CDC), there are three categories of asymptomatic patients: (a) those with recessive infection, presenting with low infectivity; (b) those with previous infection, presenting with low infectivity, may be due to the presence of antibodies; and (c) those in the incubation period with infectivity. At present, a majority of asymptomatic infections in Wuhan fall into the first two categories, with low infectivity.

Factors Associated With the Successful Implementation of Massive Virus Testing

In addition, Wuhan Health Commission announced (41), more than 50,000 medical staff and more than 280,000 community workers participated in this large-scale testing campaign. By adding 40 medical institutions and CDCs for testing, there are 63 institutions analyzing the test samples, which greatly increased the overall testing capabilities. These testing agencies also mobilized personnel and added equipment from all over the country. The number of staff in testing institutions increased from 419 to 1,032, and testing equipment increased by 215 pieces to 701. Through these safeguards, the daily testing capacity of Wuhan has increased from 300,000 to more than 1 million. However, it is particularly important to implement a program that eliminates social apprehensions, test hesitancy and prejudice; to promote the overall recovery of the economy and society; and to achieve accurate prevention and control results from testing for the virus in the entire city.

DISCUSSION

The study raises a crucial issue—the potential threats of a second surge of SARS-CoV-2 and the local governments' response to containing it. The Wuhan government has contained the SARS-CoV-2 outbreak. From March 18 to May 8, 2020, there were no new confirmed cases. Six new cases confirmed on May 9, 2020, in Wuhan, again raised the alarm for the government. The clustering epidemic in the Dongxihu district of Wuhan at the beginning of May suggested that the virus transmission was not contained during the first phase of the SARS-CoV-2 outbreak in Wuhan. Therefore, the Wuhan government decided to launch a citywide nucleic acid testing to ensure the public health safety and to contain the second surge of SARS-CoV-2 effectively. The main purpose of a virus assay was to identify people who carry the virus and to trace their close contacts. One reason for Wuhan's virus-testing program might be its large population in which many people could be (potential) carriers. In other words, to identify the confirmed positive cases and trace people in an urban city are challenging. That was why the Wuhan government launched a citywide-testing campaign.

Indeed, this was also an opportunity for the government to enhance its public image and credibility in a health crisis. Without mobilizing all possible resources, it might not be

TABLE 2 | Daily virus testing and epidemic situation in each administrative district of Wuhan.

Date	Total number of nucleic acid tests	Newly confirmed cases	Newly discharged cases	New deaths	Newly suspected cases	New asymptomatic infections
12/05	42,618	0	0	0	0	6
13/05	67,026	0	0	0	0	11
14/05	72,791	0	0	0	0	9
15/05	113,609	0	0	0	0	9
16/05	222,675	0	0	0	0	10
17/05	335,887	0	0	0	0	14
18/05	467,847	1	0	0	0	16
19/05	856,128	0	0	0	0	13
20/05	887,321	0	0	0	0	28
21/05	1,000,729	0	0	0	0	35
22/05	1,470,950	0	0	0	0	25
23/05	1,146,156	0	0	0	0	30

Wuhan municipal health commission (the epidemic situation of COVID-19 in Wuhan).

possible to carry out the citywide testing of about 6.9 million people in 10 days. To the degree that the world is still prone to SARS-CoV-2, the citywide nucleic acid testing by Wuhan's government provides an effective health model. In mid-June, 2020, Beijing Municipal government also tackled the second surge of SARS-CoV-2 with a partial lockdown in which high- and medium-risk areas were closed immediately and residents required to take nucleic acid tests if they thought they were infected. The Beijing Municipal government traced the source of the infection to Xinfadi Food Market; there were no family clusters or cross-infections. To contain the second surge of SARS-CoV-2 in the capital is mainly because of its timely early tracing (42). Similarly, Shanghai government also has the daily capacity of 70,000 tests for SARS-CoV-2, which increased to 90,000 by August 2020 (42). The three city governments' approaches indicate that China has developed a strategic plan for citywide virus testing and also to follow the trace and isolation policy, simultaneously, to prevent a new outbreak of SARS-CoV-2.

Virus assay is recognized as the "gold standard" for diagnosing the new coronavirus infection. For the virus-testing technology and quality assurance, the virus testing of RT-PCR is the main method for the diagnosis of SARS-CoV-2. The SARS-CoV-2 virus gene is used to design primers for target detection. The virus assay process of SARS-CoV-2 includes sample collection, storage, transportation, sample pre-processing virus extraction, virus amplification and detection and the interpretation of results. To confirm that a case is positive, the test results of at least two targets (ORF1ab/N/E) of the SARS-CoV-2 in the same specimen must be positive. In addition, negative results need to exclude factors that may cause false negatives. To achieve the goal of early screening, diversion of suspected cases, timely isolation and treatment of patients, in addition to pathogenic testing and diagnosis, auxiliary diagnosis can be made based on clinical symptoms and CT images.

At the outbreak of SARS-CoV-2, WHO regarded the detection of every suspected case as top priority for epidemic prevention and control. More and more countries now acknowledge the importance of virus assay and are being more compliant with expanding the scope of the test. The Central Leading Group for Responding to the Epidemic of COVID-19 in China held a meeting that called for "accelerating the improvement of detection capacity, carrying out large-scale virus", and stressed that "this is not only conducive to precise prevention and control, but also conducive to the reasonable flow of personnel, and promoting comprehensive resumption of work and production" (43). The Joint Prevention and Control Mechanism of the State Council also issued the guiding principles on effectively preventing and controlling the pandemic normalization, pointing out that the efficacy of virus assays should be improved, the scope of test expanded, and the key populations tested (44). Wuhan implemented citywide nucleic acid testing to detect confirmed cases and asymptomatic infected people, and to identify and control the sources of infection. It is direly need to ensure the public health and to bring the routine business back to life.

Because the guiding principles issued at the highest level of the Chinese government link results of epidemic prevention and control in various cities to the performance evaluation of local officials, lower-level government agencies and their leadership are encouraged to implement strict prevention measures without the distraction of other concerns, such as the demands of the 10-day nucleic acid testing campaign. This large-scale test can detect confirmed cases and asymptomatic infected people, identify and control the source of infection, thus eliminating transmission channels, minimizing the risk of transmission, and reducing the burden of the disease to the whole society. In the case of strict prevention and defense against the epidemic, China's response was to identify one case and to respond to it head-on. The strategic response here can be enabled by the SCCT to identify

key loopholes that may have triggered the second surge of the SARS-CoV-2 crisis, then mobilize all possible resources from the physical to the human to respond effectively. SCCT is appropriate in this context in that it matches crisis-response strategies to a specific crisis. China has used that strategy since Day 1 to contain the crisis; it continues to do so for subsequent surges in Wuhan, Guangzhou, Beijing and Hong Kong.

From the blanket virus assay event in Wuhan, the key to the successful implementation of this impossible task lies in the seamless connection and close cooperation of the three-level government system: city, district and community. In addition, there is continuing need for more social publicity and mobilization. In other words, to restart the daily production and life safely, the government plays a leading role in the epidemic prevention and control, not only playing the role of "Night Watcher" proposed by Adam Smith, but also playing the role of "Visible Hand." The governments should use public-service announcements and similar forms of publicity to make the citizens informed about and be persuaded to accept the value and importance of testing, and to reduce significantly individual or family anxieties. Also, with the help of the internet and big-data technology, no effort should be spared in reaching the whole staff-detection target. The amplification of virus-assay institutions and the adoption of scientific methods can ensure detection quality while improving efficiency as much as possible. With the continuous global spread and worsening of the pandemic, the role of a responsive government has become increasingly prominent. Wuhan's citywide virus assay reflects the advantages and effects of this normalized prevention and control mechanism, which is enforced by the government, linked up and down, and implemented at all levels.

It must be noted here that through the 10-day nucleic acid-testing competition in Wuhan, the shortcomings of China's public-health emergency management system were gradually revealed. Therefore, it may be useful to reform it in four ways: (a) collect information in various ways to improve the system's risk monitoring and early warning capabilities; (b) improve further the direct reporting system to facilitate the timely upload of information and reduce the tedious process of administrative intervention; and (c) strengthen the ability of scientific analysis, ensuring that the assessment of diseases not be mixed with the concept of administrative hierarchy. When encountering difficult problems, governments at all levels should organize a team of experts to conduct scientific research of the epidemic. The fourth method is to link public health with national security by increasing investment in public health, and strengthening the development of public health personnel. In addition, the epidemic also reveals that China's NGOs still fulfill secondary and passive roles in the prevention-and-control process. Without strong leadership and organization of the government, and strict joint prevention-and-control measures, this competition is unlikely to achieve the expected results in a short time. Therefore, improving the status and the role of NGOs in disease prevention and control, and expanding the breadth and depth of social participation are also key issues that need to be considered by government officials.

IMPLICATIONS OF SCCT FOR GOVERNMENTS' PANDEMIC RESPONSE

It is important to state here that, because communication practitioners have oftentimes been ill-equipped to apply known theories to resolving crises, there exists a gap between communication theory and practice (45). A reason for that disconnect is that they view theories as too abstract to be applicable in practice. To bridge that gap, then, SCCT, which is variables-driven, is critical to identifying behavioral factors that have been implicated in, say, this evolving health crisis. We, therefore, present three implications of SCCT for the Wuhan government's virus-testing program, in particular, and for health communication strategies, in general.

First, one of the challenges of the Wuhan citywide testing program was mixed messaging, by which clarity of guidelines distributed by governments and agencies was in question. Therefore, the health-communication crisis spawned initially a communication crisis—mixed messaging—that is being resolved through strategies embedded in an evolving pandemic and through tactics informed by the strategies government institutions will adopt. One such mixed messaging emanated from viral infodemic, which was implicated in increases in public depression and anxiety; however, it prodded government agencies into launching an effective health communication strategy to mitigate the negative psychological impact of COVID-19 (46, 47).

Second, rumor control. The rumor mill was rife with uncorroborated information during the initial phases of the pandemic in Wuhan. SCCT has the potential to enable health practitioners understand quickly how rumors, as social sources of influence, lead to message believability and to greater attribution of the outcomes of a crisis to organizational—that is, governmental—responsibility (48). SCCT focuses on crisis response contingent on crisis type. For example, a subjective rumor on virus testing spreads on the internet, leading to a snowball in the transmission of that rumor, complicating government's response to it. How did the Wuhan government respond to it eventually? By adopting a containment strategy of ensuring that the life cycle of the rumor was truncated, the government deprived it of further transmission.

Third, health-communication practitioners can draw upon the predictive strengths of SCCT. Zhao (49) asserts: "The social scientific approach develops predictive frameworks that uncover various crisis variables that determine the crisis communication process. While predictive frameworks have recognized the constitutive role of communication, they have also identified social constructions of crises as *naturally occurring* (emphasis added) phenomena" (p. 112). The keywords "naturally occurring" point to the inevitability of social construction as applied to the health crisis that Wuhan initially singularly experienced, constructed—and managed. It was "a process and a product of collective meaning making and ongoing negotiation through complex interactions among multiple social actors in a particular social setting" (pp. 99–100). Health-communication practitioners, even if blind-sided by the onset of a crisis, can

promptly reach for SCCT's predictive elements that offer a road map that facilitates that collective meaning making, particularly through its requirement of an identification of crisis type or its assignment to a cluster that is an initial step in assessing crisis responsibility and recommending a crisis-response strategy (50).

CONCLUSION

This study focuses on a citywide virus testing to contain the SARS-CoV-2 crisis. It explores how effectively and efficiently the local government system of Wuhan prevented the crisis by involving and mobilizing its three-tier units: city, districts and communities. The prevention-and-control strategy it employed was primarily informed by SCCT, which posits that because situational differences in organizational crises result in different impacts on an organization's post-crisis reputation, organizations are better served by adopting response strategies most appropriate to their situations. In the case of the government of Wuhan, the virus-testing program, widely administered, could provide an effective platform for responding to public anxieties and uncertainties in a fast-evolving pandemic.

Based on the experiences of the first surge in late January 2020, in the current pandemic, SARS-CoV-2 containment is likely to have effective results by implementing strict control measures to test, trace and isolate new cases. Therefore, in the second surge, the Wuhan government's robust testing of its citizens demonstrated its public-health resolve to protect them from the devastating effects of an impending SARS-CoV-2, following the diagnosis of six additional confirmed cases. Such a community-based approach to controlling COVID-19 is a massive investment that requires not only the mobilization of the local government institutions but also the understanding and cooperation of residents. Testing 6.9 million people in 10 days demonstrated the Wuhan local government's proactive control mechanism to tackle a public scourge in its attempt to create a seeming pandemic-proof city—an approach extended to cities such as Beijing, Shanghai and Xinjiang, in their attempts to contain second outbreak. While many countries are still under lockdowns, Wuhan's crisis is a plausible indication of the fate that might await all SARS-CoV-2-stricken countries post-lockdowns; therefore, the recently implemented Wuhan control mechanism (at the city, district and township levels) is poised to serve as a model to other cities.

LIMITATIONS OF THE STUDY AND FUTURE RESEARCH DIRECTIONS

This article discusses the implementation of citywide nucleic-acid testing in Wuhan. Because of the impact of the epidemic and restrictions on local blockades and 14-day isolation measures issued by governments across China, the authors could not reach into the depths of pandemic-related operations of Wuhan government departments at city, district and township levels and engage specific communities in ethnographic investigations. Because of that limitation, it is highly recommended that future researchers seek to collate evidence based on local community responses and on challenges residents faced during the lockdown. Such studies will help in designing future crisis-management-response clusters, especially for urban communities. In that way, local governments and their agencies can efficiently and effectively contain similar public-health crises in the future. Public-health scholars may investigate the role of local communities in their collective social responsibility to contain the pandemic effectively, as we have observed that people in various countries did not give it a serious attention until the governments went for partial and complete lockdown.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/supplementary material; further inquiries can be directed to the corresponding authors.

AUTHOR CONTRIBUTIONS

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Assessment of Knowledge and Practices Toward COVID-19 Prevention Among Healthcare Workers in Tigray, North Ethiopia

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Background: The incidence rate of coronavirus disease 2019 (COVID-19) is increasing in several countries despite that public health measures are put in place. Given that COVID-19 is a newly emerging disease, there is little knowledge about the disease. The present study aims to assess knowledge, perception, and preventive practices toward COVID-19 among health workers in Tigray, North Ethiopia.

Materials and Methods: A health facility-based cross-sectional study was conducted among health professionals working in public hospitals. Data were collected between April and May 2020. The researchers included 403 participants and recruited them via a simple random sampling technique. To collect data, the researchers prepared a structured questionnaire guided by the WHO survey questions. Data were entered into Epi-info 7 and exported to SPSS version 20.00 for analysis. The researchers applied descriptive and inferential statistical analyses. Tables and graphs were used to describe data, and multivariate binary logistic regression was used to determine factors affecting knowledge, perception, and practices toward COVID-19 prevention.

Results: Among the participants, 79, 88, and 64.3% of them had adequate knowledge, positive perception, and good practice toward preventing COVID-19, respectively. Besides, 92% of the study participants knew that the COVID-19 virus does not have curative treatment and vaccine. The findings revealed that 55% of the respondents did not use the necessary personal protective equipment (PPE) at all times. The result showed that being female [AOR: 2.43, 95% CI (1.50–3.94)] and having a work experience of 2–5 years [AOR: 2.44, 95% CI (1.10–5.39)], news media as a source information [AOR: 7.11, 95% CI (3.07–16.49)], social media as a source information [AOR: 4.59, 95% CI (2.15–9.84)], and governmental website as a source information [AOR: 4.21, 95% CI (2.15–8.27)] were reported as protective factors; and being single [AOR: 0.15, 95% CI (0.03–0.75)] was reported as risk factor toward the prevention of COVID-19.

Conclusion: Most health workers had adequate knowledge and positive attitude toward COVID-19; nevertheless, a significant proportion of health workers had poor practice toward the prevention of COVID-19, including the use of PPE. Additionally, some groups of health professional showed poor practices of implementing the public health measures, hence the call for them to improve in the prevention and control of COVID-19.

INTRODUCTION

Coronavirus disease 2019 (COVID-19) is currently a global health and public health emergency (1). The first outbreak of severe respiratory syndrome associated with coronavirus was first reported in 2003 (2). In December 2019, Wuhan, Hubei Province, China, became the center of an outbreak of pneumonia of unknown cause, which was later known as a novel COVID-19 (3, 4). The COVID-19 burden has increased around the world in disease, death, and economic crises (5). Globally, there are 31,867,173 infections and 967,258 deaths on September 24, 2020 (6). Africa has recorded 1,420,629 cases and 34,327 deaths as of September 24, 2020 (6). The first reported coronavirus patient in Ethiopia, a Japanese citizen, was observed on March 13, 2020 (7). There are more than 71,083 cases and 1,141 deaths in Ethiopia on September 23, 2020 (8). Tigray reported 5,316 cases and 27 deaths as of September 23, 2020 (9).

Several countries put public health measures in place to control the transmission of COVID-19. Nevertheless, the compliance with these measures is not at the desired level. Some of the reasons include long-term vulnerability, lack of personal protective equipment (PPE), overcrowding, lack of isolation facilities, contaminated environment, and possibly a lack of knowledge and understanding among healthcare workers (HCWs) (10–12).

HCWs are at high risk for COVID-19 because of the nature of their work, which exposes them to infectious diseases on a daily basis. Worldwide, many HCWs are infected with the COVID-19 and have lost their lives (5, 13). Unless special attention is paid to the safety of HCWs and their workplaces, the system will lose many HCWs and severely undermine the capacity of anti-COVID-19 and other infectious diseases worldwide. Unlike other people, HCWs have a double source of COVID-19 in their community and workplaces. The main cause include long-term vulnerability, lack of PPE, overcrowding, lack of isolation facilities, contaminated environment, and possibly a lack of knowledge and understanding among HCWs (11, 14). HCWs are a common source of family, patient, and community infections (12, 14).

The World Health Organization (WHO) recommends the prevention of COVID-19 transmission by maintain social distancing (at least 1 m) from any person by avoiding close

contacts, hand hygiene (wash with soap or using alcohol-based hand sanitizers), and wearing PPE (15, 16). The WHO also launched a number of online training courses and materials on COVID-19 in different languages to facilitate the preventive mechanisms, including increasing awareness and capacity building HCWs in preparation activities (17). Often, misunderstandings among HCWs have slowed down efforts to provide the necessary treatment, which has led to the rapid spread of infection in hospitals and has endangered patients' lives (18, 19).

It is also important to improve the knowledge and prevention practice of HCWs and the community through regular updates on COVID-19 (15, 19). If HCWs have access to information, they will improve their knowledge, implement preventive devices to COVID-19, and provide better care for patients, families, and the community (11, 20).

Studies showed that HCWs have 93.2% good knowledge, 95% positive attitude, and 88.7% good practice regarding COVID-19 (21). Reports from the healthcare professionals in Greece toward severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) showed that 88.3% of the subjects had good knowledge and 71% of the participants agreed to temporary travel restrictions (22). Cross-sectional studies in Egypt showed that the average correct answer for COVID-19 prevention-related questions was 80.4% with a mean knowledge score of 18.5 ± 2.7 out of 24. About 83.1% of the participants feared COVID-19, and 89.2% said they had a higher risk of COVID-19 than others (23). Additionally, there are different works on knowledge and practices on COVID-19 in Ethiopia and Africa (24–27).

There is an inadequate study of COVID-19 prevention practice of HCWs in Ethiopia in general and in Tigray in particular. Early prevention of the disease before its entry has paramount importance. The level of knowledge, perception, and preventive practice of health workers is indispensable to successful early prevention of the disease. Thus, this research paper is supposed to fill the gap by identifying the status of knowledge, perception, and preventive practice of HCWs toward COVID-19. Besides, the study will be helpful by shedding light on intervention areas that need to be pursued by policymakers. This study aims to assess the knowledge, perception, and practice of HCWs about COVID-19 in Aksum University Comprehensive and Specialized Hospital (AKUCSH) and Saint Mary's General Hospital in Tigray Regional State of Northern Ethiopia.

Based on these considerations, therefore, the following hypotheses were formulated:

1. Age, gender, work experience, news media, social media, governmental website, family, and friends as source of

information would significantly predict knowledge of COVID-19 among health workers.

2. Age, ethnicity, news media, social media, governmental website, family, and friends as source of information would significantly predict perception of COVID-19 among health workers.

3. Age, gender, marital status, news media, family, and friends as source of information would significantly predict practices of COVID-19 prevention among health workers.

MATERIALS AND METHODS

Study Design, Setting, and Population

A health facility-based cross-sectional study design was employed among health workers. The study was conducted in AKUCSH and Saint Mary's General Hospital in Tigray Regional State of Northern Ethiopia. Axum city is located 1,045 km away from Addis Ababa, the capital city of Ethiopia, and 262 km from Mekele capital city of Tigray regional state. Axum city has five kebeles (a small administrative unit consisting of 20,000 population), one referral and teaching hospital, one general hospital, two health centers, four health posts, and 10 different level private clinics. AKUCSH provides curative and preventive services and has 330 HCWs including 22 specialists, 84 general practitioners (GPs), 218 nurses, and six health officers. AKUCSH provides health services for 3.6 million people on average. Saint Mary's General Hospital, the other study setting, was established in 1961 and has 258 HCWs including six specialists, 17 GPs, 212 nurses, eight health officers, seven pharmacists, and eight laboratory technicians.

HCWs, including physicians, pharmacists, nurses, and laboratory technicians, who have a work experience of 6 months, were eligible to be included in the study. HCWs who were on annual leave and were not willing to participate were excluded.

Sample Size and Procedure

The sample size was determined using the formula of the single population proportion. The following parameters were used to calculate the sample size: p = proportion HCWs who are knowledgeable about COVID-19 [50%, no previous study found in Ethiopia; 95% CI ($Z_{1-\alpha/2}$) = 1.96], and 5% degree of marginal error (d). Assuming a 5% non-response rate, the minimum required sample size was 403. A simple random sampling technique was employed to recruit study participants.

Variables and Measurements

The knowledge, perception, and practice toward COVID-19 prevention were measured based on the WHO (2020) Survey Tool and guidelines for National comprehensive COVID 19 management Federal ministry of Health (FMOH), Ethiopia (28). The questions about the knowledge of COVID 19 prevention had 15 items, the questions about the respondents' perception toward COVID 19 prevention had 11 items, and the questions about the respondents' practice toward COVID 19 prevention had 10 items. The rest of the questions were about the respondents' sociodemographic information. All the questions contained the categories "yes," "no," and "don't know." The respondent's

TABLE 1 | Sociodemographic characteristic of health workers at Aksum University Comprehensive and Specialized Hospital (AKUCSH) and Saint Mary's General Hospital in Tigray Regional State of Northern Ethiopia ($n = 403$), April to May 2020.

Characteristics		Frequency	Percent
Age	≤25	104	26.9
	26–29	143	37.0
	>30	140	36.2
Sex	Male	200	51.7
	Female	187	48.3
Marital status	Single	204	52.7
	Married	176	45.5
	Divorced	7	1.8
Religion	Orthodox	372	96.1
	Muslim	13	3.4
	Protestant	2	0.5
Ethnicity	Tigray	322	83.2
	Amara	57	14.7
	Oromo	8	2.1
Profession	Physician	80	20.7
	Nurse	209	54.0
	Midwifery	41	10.6
	Pharmacy	35	9.0
	Laboratory technician	22	5.7
Work experience in the year	<2 years	157	40.6
	2–5 years	143	37.0
	≥5 years	87	22.5
Have heard about COVID-19	Yes	386	99.7
	No	1	0.3
Training on COVID-19	Yes	273	70.5
	No	114	29.5

knowledge toward COVID 19 prevention was indicated by two categories: "Inadequate knowledge" for <9 of 15 items (<60%) and "adequate knowledge" for ≥9 of 15 items (≥60%) (27, 29, 30). The respondent's perception toward COVID-19 was indicated by two categories: "negative perception" for <7 of 11 items (≤60%) and "positive perception" for ≥7 of 11 items (>60%) (27, 29, 30); a reliability coefficient (Cronbach's alpha) of 0.60 was obtained in a pilot testing of the scale, while the current data set yielded 0.65. Especially regarding the practice toward COVID-19, the respondents were asked about going to crowded places, wearing masks in public, maintaining social distance, hand washing, avoiding handshaking, and obeying government restrictions. The respondents' practices toward COVID-19 prevention were indicated by two categories: "poor practice" for <5 of 10 items (<50) and "good practice" for ≥5 of 10 items (≥50%) (27, 29, 30).

Data Collection Process and Quality Assurance

Data were collected from April to May 2020, via an interview with a pretested and structured questionnaire used from the WHO survey questions. The questionnaire includes

FIGURE 1 | Knowledge of COVID-19 among health workers at Aksum University Comprehensive and Specialized Hospital (AKUCSH) and Sain't Marry's General Hospital in Tigray Regional State of Northern Ethiopia.

FIGURE 2 | Perception of COVID-19 among health workers at Aksum University Comprehensive and Specialized Hospital (AKUCSH) and Sain't Marry's General Hospital in Tigray Regional State of Northern Ethiopia.

sociodemographics, disease knowledge, disease perception, and preventive practices. The data extraction sheet was prepared in English, then translated into the local language (Tigrigna), and translated back into English by a professional. To establish face validity and translation quality, the questionnaire was tested on 5% of the total sample size outside of the study site by data collectors and supervisors. A few questions, language clarity, and information were revised; and the questionnaire was finalized for the study by the principal investigators. Three data collectors and supervisors were recruited outside of the study site, and they were given training for 2 days. The supervisors supervised the process of data collection, checked the data

completeness consistency, and communicated with principal investigators daily.

Data Analysis

After being coded, data were entered into Epi-info 7 and exported to SPSS version 20.00 for analysis. Simple descriptive statistics such as frequency, percentage, and mean were employed. Tables, charts, and graphs were used to present the result of the analyzed data. A binary logistic regression model was used to determine sociodemographic factors predicting knowledge, perception, and practice toward prevention and control of COVID-19. Variables with $p < 0.2$ were recruited for multivariate logistic regression

FIGURE 3 | Practice of COVID-19 prevention among health workers at Aksum University Comprehensive and Specialized Hospital (AKUCSH) and Sain't Marry's General Hospital in Tigray Regional State of Northern Ethiopia.

analysis. Adjusted odds ratio with 95% of CI was calculated, and $p < 0.05$ were considered as a cutoff for the statistically significant association.

Ethics Statement

Ethical clearance was obtained on June 19, 2020, from the Institutional Review Committee (IRC) (IRB Number: IRB I79/2020) of the College of Medicine and Health Sciences, University of Aksum. A permission letter was received from those administrative bodies of the health facilities. Written consent was obtained from every study participant included in the study during data collection time after the objectives of the study and the right to withdraw from the study at any time were explained. The data were kept confidential, and the results did not identify the respondents personally.

RESULTS

A total of 403 health workers were included in the study, with a response rate of 96%. The mean age of the study participants was 28.2 + 5.1 years, with a minimum and maximum age of 19 and 46 years, respectively. More than half (51.7%) of the participants were male, and the majority of the participants (52.7%) were single. In terms of profession, 54% of participants were nurses followed by 20.7% physicians, 10.6% midwives, 9% pharmacists, and 5.7% laboratory technicians. The majority of the participants (83.2%) were ethnic Tigray. **Table 1** describes the demographic characteristics of the study participants.

Knowledge, Perception, and Practice of Healthcare Workers Toward COVID-19

More than three fourths (79%) of health workers were knowledgeable about COVID-19 (**Figure 1**). The majority of participants (92%) knew that the COVID-19 has no special treatment and vaccine (**Figure 1**). Likewise, 87.9% of HCWs had a positive perception of COVID-19. Almost all participants (97.4%) perceived that washing hands with soap and water was the best prevention of COVID-19 (**Figure 2**). More than half (64.3%) of health workers had good practice toward COVID-19 prevention (**Figure 3**). Almost all of the health workers (96.1%) kept their hand hygiene (wash with soap or using alcohol-based hand sanitizers). More than half of health workers (54.8%) did not use the necessary PPE at all times (**Figure 3**).

Factors Associated With Knowledge

Age, gender, work experience in years, news media as source of information, social media, governmental website, family, and friends were included in the multivariable analysis. In the multivariable logistic regression analysis, work experience and governmental website as source of information were significantly statistically associated with adequate knowledge of COVID-19. Participants with work experience between 2 and 5 years were two times [AOR: 2.44, 95% CI (1.10–5.39)] more likely to be knowledgeable than participants with ≥5 years of work experience. Participants having a governmental website as a source information were four times [AOR: 4.21, 95% CI (2.15–8.27)] more likely to be knowledgeable about COVID-19 prevention than those who were not (**Table 2**).

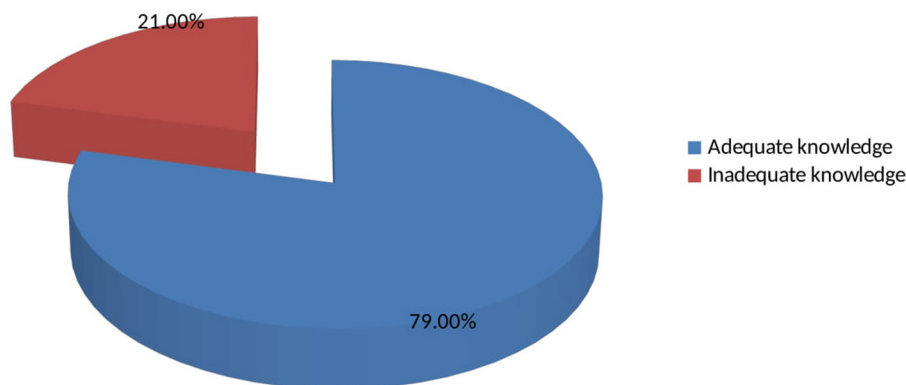**TABLE 2 |** Univariate and multivariate logistic regression analyses of knowledge about COVID-19 among health workers at Aksum University Comprehensive and Specialized Hospital (AKUCSH) and Saint Mary's General Hospital in Tigray Regional State of Northern Ethiopia (n = 403), April to May 2020.

Variable		COVID-19 knowledge		COR	AOR
		Adequate	Inadequate		
Age	≤25	34 (32.7)	70 (67.3%)	2.13 (1.18–3.85)*	1.79 (0.83–3.89)*
	26–29	20 (14%)	123 (86%)	0.71 (0.38–1.35)*	0.61 (0.30–1.23)*
	>30	26 (18.6%)	114 (81.4%)	1	1
Sex	Male	167 (83.5)	33 (16.5)	1	1
	Female	140 (74.9)	47 (25.1)	0.59 (0.39–0.97)*	0.68 (0.39–1.19)*
Work experience in the year	<2 years	32 (20.4%)	125 (79.6%)	1.46 (0.72–2.95)*	1.66 (0.67–4.13)*
	2–5 years	35 (24.5%)	108 (75.5%)	1.86 (1.09–3.72)*	2.44 (1.10–5.39)*
	≥5 years	13 (14.9%)	74 (85.1%)	1	1
News media as a source information	Yes	278 (80.8%)	66 (19.2%)	2.03 (1.01–4.06)*	1.60 (0.74–3.48)*
	No	29 (67.4%)	14 (32.6%)	1	1
Social media as a source information	Yes	245 (82.2%)	53 (17.8%)	2.01 (1.17–3.46)*	1.73 (0.91–3.27)*
	No	62 (69.7%)	27 (30.3%)	1	1
Governmental website as a source information	Yes	182 (89.2%)	22 (10.8%)	3.84 (2.24–6.59)*	4.21 (2.15–8.27)**
	No	125 (68.3%)	58 (31.7%)	1	1
Family and friends as a source information	Yes	146 (82.5%)	31 (17.5%)	1.43 (0.87–2.37)*	0.58– (0.29–1.14)*
	No	161 (76.7%)	49 (23.3%)	1	1

COR, crude odds ratio; AOR, adjusted odds ratio.
$^{*}p < 0.05$; $^{**}p < 0.001$.

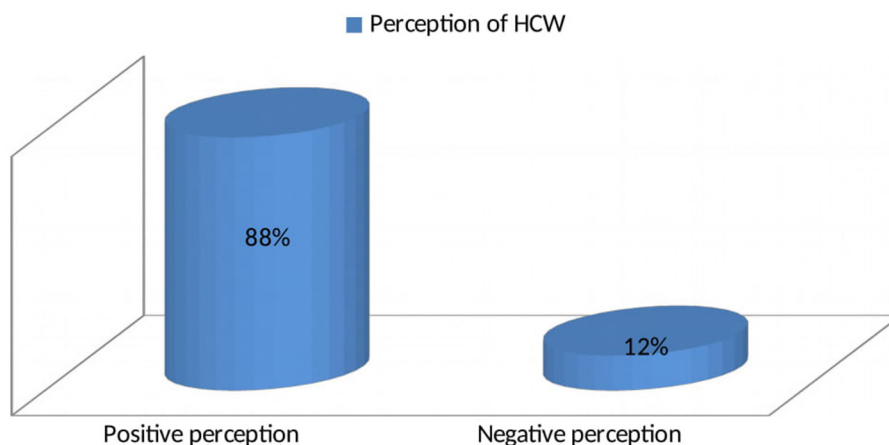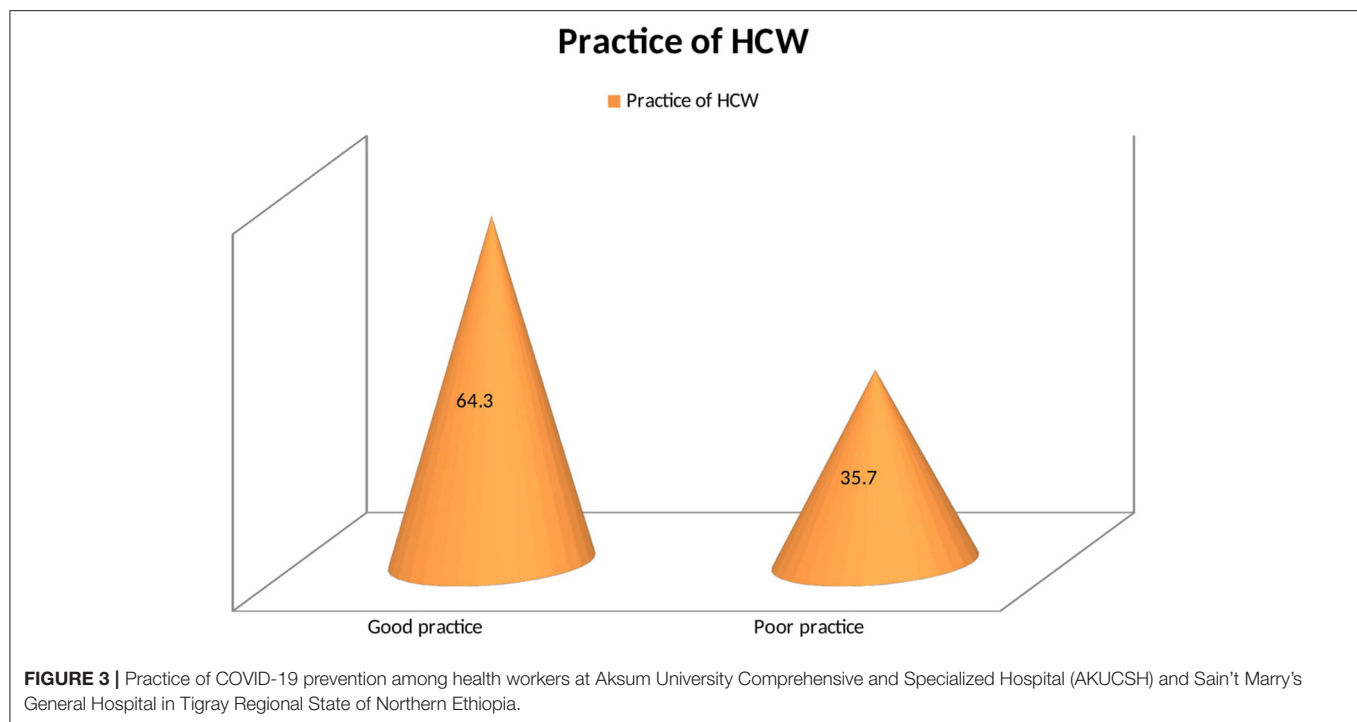**TABLE 3 |** Univariate and multivariate logistic regression analyses of perception about COVID-19 among health workers at Aksum University Comprehensive and Specialized Hospital (AKUCSH) and Saint Mary's General Hospital in Tigray Regional State of Northern Ethiopia, (n = 403), April to May 2020.

Variable		COVID-19 perception		COR	AOR
		Positive	Negative		
Age	≤25	92 (88.5%)	12 (11.5%)	0.70 (0.33–1.49)*	0.74 (0.31–1.76)*
	26–29	130 (90.9%)	13 (9.1%)	0.53 (0.26–1.11)*	0.59 (0.26–1.37)*
	>30	188 (84.3%)	22 (15.7%)	1	1
News media as a source information	Yes	316 (91.9%)	28 (8.1%)	8.94 (4.37–18.27)**	7.11 (3.07–16.49)**
	No	24 (55.8%)	19 (44.2)	1	1
Social media as a source information	Yes	278 (93.3)	20 (6.7%)	6.05 (3.19–11.49)**	4.59 (2.15–9.84)**
	No	62 (69.7%)	27 (30.3%)	1	1
Governmental website as a source information	Yes	191 (93.6%)	13 (6.4%)	3.35 (1.71–6.58)**	1.53 (0.66–3.54)*
	No	149 (81.4%)	34 (18.6%)	1	1
Family and friends as a source information	Yes	170 (96%)	7 (4%)	5.71 (2.49–13.11)**	2.25 (0.81–6.29)*
	No	170 (81%)	40 (19%)	1	1

COR, crude odds ratio; AOR, adjusted odds ratio.
$^{*}p < 0.05$; $^{**}p < 0.001$.

Factors Associated With Perception

Age, news media, social media, governmental website, family, and friends as source of information were included in the multivariable analysis. In the multivariable logistic regression analysis, news media and social media as source of information were significantly associated with a positive perception of COVID-19. Participants having news media as source of information were seven times [AOR: 7.11, 95% CI (3.07–16.49)] more likely to have a positive perception toward COVID-19 than participants who did not attend news media. Those with exposure to social media [AOR: 4.59, 95% CI (2.15–9.84)] was found have a positive perception than those with non-exposure to social media (**Table 3**).

Factors Associated With the Practice

Age, gender, marital status, news media as source of information, and family and friends as source of information were included in the multivariable analysis. In the multivariable logistic regression analysis, gender and marital status were significantly statistically associated with good knowledge of COVID-19. Males were two times [AOR: 2.43, 95% CI (1.50–3.94)] more likely to have good practice to prevent COVID-19 than females. The odds of

TABLE 4 | Univariate and multivariate logistic regression analyses showing predictors of practice to prevent COVID-19 among health workers at Aksum University Comprehensive and Specialized Hospital (AKUCSH) and Saint Mary's General Hospital in Tigray Regional State of Northern Ethiopia (n = 403), April to May 2020.

Variable		Practice toward COVID-19		COR	AOR
		Good	Poor		
Age	≤25	70 (67.3%)	34 (32.7%)	0.71 (0.42–1.20)*	1.34 (0.71–2.53)*
	26–29	96 (67.1%)	47 (32.9%)	0.71 (0.44–1.16)*	0.86 (0.51–1.45)*
	>30	83 (59.3%)	57 (40.7%)	1	1
Sex	Male	111 (55.5%)	89 (45.5%)	2.26 (1.47–3.47)**	2.43 (1.50–3.94)**
	Female	138 (73.8%)	49 (26.2%)	1	1
Marital status	Single	138 (67.6%)	66 (32.4%)	0.36 (0.08–1.65)*	0.15 (0.03–0.75)*
	Married	108 (61.4%)	68 (38.6%)	0.47 (0.10–2.18)*	0.26 (0.05–1.28)*
	Divorced	3 (42.9%)	4 (57.1%)	1	1
News media as a source information	Yes	227 (66.0%)	117 (44.0%)	1.85 (0.98–3.51)*	1.65 (0.81–3.36)*
	No	22 (51.2%)	21 (48.8%)	1	1
Family and friends as a source information	Yes	119 (67.2%)	58 (32.8%)	1.26 (0.83–1.92)*	1.13 (0.71–1.80)*
	No	130 (61.9%)	80 (38.1%)	1	1

COR, crude odds ratio; AOR, adjusted odds ratio.
*$p < 0.05$; **$p < 0.001$.

reporting good practice to prevent COVID-19 were lower among single participants compared with divorced participants [AOR: 0.15, 95% CI (0.03–0.75)] (**Table 4**).

DISCUSSION

This study aimed to assess knowledge, perception, and practice toward the prevention and control of the COVID-19 outbreak among HCWs in Northern Ethiopia. The finding showed that the majority of health workers had adequate knowledge (79%) of COVID-19. This finding is consistent with findings from other studies in North Ethiopia, 74% (27). The knowledge level of prevention and control of the COVID-19 outbreak in our study were lower than those of the cross-sectional study conducted in Iran, 85%; Henan China, 89%; and Pakistan, 93.2% (21, 31, 32). But these findings are higher than the knowledge level of prevention and control of the COVID-19 outbreak seen in studies conducted in Saudi Arabia, 51% (33); and Iran, 61% (34). The difference could be due to the frequency and focus of presentation of COVID-19 in media and the public in these countries. The commitment and leadership of the government to give focus on informing the public about the pandemic may also be another reason for the difference. This builds on the finding on the source of knowledge about COVID-19, which is similar to the study conducted on China residents (29). Most HCWs get information from the news media (89%) and social media (77%) about the COVID-19. Interestingly, this finding differs from that in the study in Saudi Arabia, which indicates that the ministry of health website is one of the main sources of information (33). These findings implied that the Ethiopian Government and the Ministry of Health need to plan health education programs about this COVID-19 outbreak.

Several variables predicted the level of knowledge regarding COVID-19 in our setting. Participants with work experience of between 2 and 5 years were two times more likely to

be knowledgeable than participants with ≥5 years of work experience. This is because mobile internet and social media or technology (Facebook, YouTube, Telegram, and Twitter) are easily accessible by most health professionals at home and in the workplace. Participants having a governmental website as a source information was four times more likely to be knowledgeable those who were not, which is in agreement with a study conducted in Saudi Arabia where most health workers have access to information about COVID-19 and other infectious diseases through the Ministry of Health website (33, 35). This implied that the Ethiopian Government and the Ministry of Health need to use the governmental website to disseminate information to HCWs.

In this study, the majority (87.9%) of health workers had a positive perception of COVID-19. This finding is higher than the findings from other studies in North Ethiopia, 74% (27); Saudi Arabia, 51% (33); and Iran, 61% (34). The difference could be due to the frequency and focus of presentation of COVID-19 in media and the public in these countries. Almost all participants (97.4%) perceived that washing hands with soap and water were the best COVID-19 prevention. Majority of HCWs, 89.4%, recognized that COVID-19 is a fatal disease. This study also revealed that participants having news media as a source of information and exposure to social media were associated with positive perception of COVID-19. This is consistent with other studies where social media, if used wisely, can serve as a powerful tool to change people's behavior and improve the health of individuals and nations (36). This is because mobile internet and social media or technology (Facebook, YouTube, Telegram, and Twitter) are easily accessible by most health professionals at home and in the workplace. This implied that the Ethiopian Government and the Ministry of Health need to use news and social media to disseminate information to HCWs.

More than half (64.3%) of health workers had good practice toward COVID-19 prevention. Almost all of the health workers

(96.1%) kept hand hygiene (wash with soap or using alcohol-based hand sanitizers) consistently. This is similar to the findings of studies conducted in China and the United Arab Emirates (29, 32, 37, 38). More than half of health workers (54.8%) did not use the necessary PPE at all times, maybe due to lack of PPE, not comfortable using the PPE, negligence, lack of safety and health education, and lack of knowledge and practice. Males were two times more likely to have good practice to prevent COVID-19 than females. Interestingly, this finding differs from those previous findings: a significant association between male gender and potentially dangerous practices toward COVID-19 was found in this study (29, 39–41). This is because stay-at-home orders also make it difficult for many women to procure food for cooking, one of their key responsibilities directly affected by COVID-19. Some women will need to decide to spend time outside the home to procure either safe water or food for their children and families. And food insecurity may affect women more than men, as seen in a study from Ethiopia (42).

The study has the following limitations. First, findings from a cross-sectional study design could not confirm the cause-and-effect relationship. Second, there may be an information bias given the collected data were self-reported. Third, health workers were the study participants; and the level of knowledge, perception, and practice may be different from that of the public.

CONCLUSIONS

Most health workers have adequate knowledge; nevertheless, a significant proportion of health workers had poor practice toward the prevention of COVID-19, including the use of PPE. Additionally, some groups of health professional had poor practices of implementing the prevention and control of COVID-19, hence the call for them to improve in the prevention and control of COVID-19. The majority of health workers do not use the necessary PPE at all times. Work experience, governmental website as a source information, and sex were protective factors; and ethnicity and marital status were risk factors toward prevention and control of COVID-19. These imply target areas and groups of HCWs to focus on preventing the spread of the coronavirus. We recommend for researchers to

conduct qualitative study and to include the variables that could not be addressed using a cross-sectional study design.

DATA AVAILABILITY STATEMENT

The data supporting the conclusions of this article are included in the article. The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation, to any qualified researcher.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Ethical clearance was obtained from the Institutional Review Committee (IRC) of the College of Medicine and Health Sciences, University of Aksum. A permission letter was received from those administrative bodies of the health facility's verbal. Written consent was obtained from all participants after they were informed on the purpose of the study. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpubh.2021.614321/full#supplementary-material

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Social Class and Changes in Australian Women's Affect and Alcohol Consumption During COVID-19

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Introduction: Before the pandemic, mid-life women in Australia were among the "heaviest" female alcohol consumers, giving rise to myriad preventable health risks. This paper uses an innovative model of social class within a sample of Australian women to describe changes in affective states and alcohol consumption patterns across two time points during COVID-19.

Methods: Survey data were collected from Australian mid-life women (45–64 years) at two time points during COVID-19—May 2020 (N = 1,218) and July 2020 (N = 799). We used a multi-dimensional model for measuring social class across three domains—economic capital (income, property and assets), social capital (social contacts and occupational prestige of those known socially), and cultural capital (level of participation in various cultural activities). Latent class analysis allowed comparisons across social classes to changes in affective states and alcohol consumption patterns reported at the two time points using alcohol consumption patterns as measured by the Alcohol Use Disorders Identification Test—Consumption (AUDIT-C) and its component items.

Results: Seven social classes were constructed, characterized by variations in access to capital. Affective states during COVID-19 differed according to social class. Comparing between the survey time points, feeling fearful/anxious was higher in those with high economic and cultural capital and moderate social capital ("emerging affluent"). Increased depression was most prominent in the class characterized by the highest volumes of all forms of capital ("established affluent"). The social class characterized by the least capital ("working class") reported increased prevalence of uncertainty, but less so for feeling fearful or anxious, or depressed. Women's alcohol consumption patterns changed across time during the pandemic. The "new middle" class—a group characterized by high social capital (but contacts with low prestige) and minimal economic capital—had increased AUDIT-C scores.

Conclusion: Our data shows the pandemic impacted women's negative affective states, but not in uniform ways according to class. It may explain increases in alcohol consumption among women in the emerging affluent group who experienced increased feelings or fear and anxiety during the pandemic. This nuanced understanding of the vulnerabilities of sub-groups of women, in respect to negative affect and alcohol consumption can inform future pandemic policy responses designed to improve mental health and reduce the problematic use of alcohol. Designing pandemic responses segmented for specific audiences is also aided by our multi-dimensional analysis of social class, which uncovers intricate differences in affective states amongst sub-groups of mid-life women.

Keywords: alcohol, women, social class, survey, pandemic (COVID-19), anxiety, depression, uncertainty

INTRODUCTION

The COVID-19 pandemic has been disorientating and disruptive for many Australians. Although Federal and State governments have had success in controlling SARS-CoV-2 infection rates [1], the measures taken to suppress viral spread, including social distancing and lockdown restrictions, have had far reaching consequences. These include impacts on the economy and the ability to socialize at work, with friends, and through recreational and cultural activities. Some data suggest that, in Australia, the impact has been particularly pronounced for certain sub-sets of the population, particularly those who are already facing hardships or vulnerability [2, 3], with emerging evidence that this result is mimicked internationally [4, 5]. The nuanced impacts of the pandemic, which likely differ between groups of women, require close examination. Differences in possible sequelae of the strategies implemented to reduce COVID-19 risk, including affective states (e.g., changes in feelings of fear, anxiety, or depression) and alcohol consumption, require identification because of their impact on population health; central to the present study, the physical and social costs of mental health decline and health risks associated with alcohol consumption. The nature of Australian women's alcohol consumption before the pandemic, and the unprecedented change in Australians' life circumstances evoked through COVID-19 suppression policies, need to be examined together because there is a possibility that the latter may impact adversely on the former.

Before the emergence of COVID-19, we had commenced a study designed to explore the role of alcohol in the lives of women from different social classes during the life stage defined as "mid-life" (45–64 years). Women in mid-life consume alcohol more than any other age group [6], despite the fact that high frequency drinking is associated with myriad acute and chronic health risks including liver disease, high blood pressure, overweight and obesity and cancer [7]. For this reason, adults in mid-life are identified as a priority group in Australia's National Alcohol Strategy 2019–2028 [8]. Early data from our study suggest that mid-life women consumed alcohol to release stress and also that women from different social class groups consume alcohol at different levels and for varying reasons, requiring different public health responses [9, 10]. National data emerging during

the COVID-19 pandemic showed that the frequency of alcohol consumption increased amongst Australian women [11]. Of the sample surveyed ($n = 561$) 47.9 per cent of women self-reported an increase of 1–2 standard drinks of alcohol per week. These data also show alcohol consumption amongst women increased more than amongst men (22.8 per cent compared to 17.9 per cent).

Albeit this report was not designed to capture detail specific enough to develop targeted public health policy responses (e.g., by way of targeted messaging). However, psychological distress amongst Australians at the outset of the pandemic was found to be associated with increases in alcohol consumption [11]. This is important, given we know that consuming alcohol is linked to broader environmental conditions; for example, the conditions leading to psychological distress and associated alcohol consumption are not uniform. As such, public health recommendations for—in this case, reducing consumption—is contingent on the "real possibilities" for target audiences [12]. Women's affective states during the pandemic provide an important context to their sense of risk and specifically, the negative affect stemming from the impact of pandemic countermeasures (including various lockdowns and restrictions), and is likely discernible by social class—that is, by the resources and levels of advantage that shape women's daily living. Stress and isolation, as common reasons for women's alcohol consumption gleaned in our previous research are potentially inflated by the various environmental and commercial aspects of alcohol consumption during COVID-19 lockdowns that might make limiting alcohol difficult [13].

This paper describes differences in Australian women's affective states during COVID-19 and their alcohol consumption patterns according to social class. We interpret any change across two time points in affect and consumption and investigate women's experiences of living throughout times of the various restrictions put in place by the Government. Importantly, we have used a novel approach to operationalize social class that extends beyond simple economic, employment, and educational markers, recently used in the UK and Australia [14, 15] and is based on the seminal work of [16]. This relational model has contemporary relevance to the nuances of social class divisions that extend beyond wealth to the social and cultural dimensions

that shape life chances and health-related outcomes, thus offering advancement over previous influential measures for calculating social class (14). This model has particular utility for investigating diversity in responses to the pandemic because it emphasizes the "mutual constitution" (17) of economic and social facets in understanding the structuring of class and of inequalities, and is suitable for investigating the unintended consequences of countermeasures that manifest in tensions "between health and wealth" during the COVID-19 pandemic (18).

Data reported here were collected through an online survey as part of a broader national study of Australian women's alcohol consumption and their perceptions of the alcohol-related risk of breast cancer. The specific aim was to address the question, *does social class differentiate changes in alcohol consumption patterns and changes in affect during COVID-19?* To summarize, we tested the proposition that the impacts of the pandemic would be felt differently, in terms of change in affect and alcohol consumption patterns, by women in different social class groups in Australia.

METHODS

We conducted online surveys with mid-life women in Australia at two time points during COVID-19. A commercial panel was provided by Qualtrics (19) and a quota system was used by Qualtrics to recruit survey respondents who identified as female, were aged 45–64 years, initially recruiting for evenly distributed tertiles of household income, based on ABS definitions of "low," "medium," and "high" (20). Respondents with existing chronic conditions were excluded. A sample size of 600 was required to achieve a 4% margin of error with confidence intervals of 95%. To adjust for an expected 50% attrition between waves and ensure study power at time point 2, 1,200 respondents were required at time point 1.

The first survey was conducted in May 2020, not long after social distancing and various lockdowns and restrictions began in Australia[1]. A follow-up survey (with the same women) was undertaken 2 months later, in July 2020, when viral transmission was more controlled, infection rates reduced, and restrictions eased.

The survey comprised various items measuring general health status and risk perceptions, informing our broader study on mid-life women's alcohol consumption. Only those items that inform our analysis of the class-based differences in changes across time in feelings and alcohol consumption are reported in this paper; the others will be reported elsewhere. Herein, we report between social class group comparisons of changes between two time points during COVID-19 in terms of AUDIT-C (21) scores (an index of problematic alcohol consumption) and in changes in affect measured as yes or no responses for six positive and two negative affective states (explained in detail below).

Data were analyzed using Stata (version 16, Stata Corporation, College Station, TX, USA). Statistical patterns across social classes were examined using Kruskal-Wallis, Chi-square and Fisher's exact as appropriate.

Survey Items
Demographic Measures
The survey items that inform this analysis include demographic information: age, relationship status, parenting status, living arrangements, the number of children living with them, education, household income and assets (property and savings), and post-code. Respondents reported their usual employment status and whether their work status or conditions had changed since the emergence of COVID-19.

Measures of "Capital" Used to Construct Social Class Categories
To construct social class groups, three forms of capital were measured (15). The questions replicate those utilized by Savage et al. in the 2011 Great British Class Survey to map class divisions in the UK (14). The survey tool was later reproduced by Australian researchers Sheppard and Biddle in 2015 to identify stratification in Australian society (15). Firstly, *Economic capital* was measured using household income and assets. Assets were measured by combining responses to the questions: *What is your annual income before tax or anything else is taken out?* (responses were indicated by income brackets provided); *What would you say is the approximate value of the property owned or mortgaged by you?* and *Roughly how much do you have in savings?* (<$20,000; $20,000 to <40,000, $40,000 to <60,000, $60,000 to <80,000, $80,000 to <100,000, $100,000 to <150,000 and $150,000 or more). Secondly, *Social capital* was measured by totalling the number of a range of known occupations within the respondent's social contacts (i.e., yes = 1) and the average prestige of those occupations. Occupational prestige was assigned using the Australian Socioeconomic Index 2006—a validated index for occupational prestige (22). Occupations included: secretary, nurse, teacher, cleaner, university lecturer, artist, electrician, office manager, solicitor, farm worker, chief executive, software designer, call center worker, and postal worker. Thirdly, *Cultural capital* was measured by a count of "highbrow" and "emerging" cultural activities (where 1 = yes), as per Bourdieu's description of cultural tastes. Respondents selected activities they had engaged in within the preceding 12 months from a list of possible cultural activities. The activities included: seen plays or gone to the theater, watched ballet or dance, gone to the opera, gone to museums or galleries, listened to jazz, listened to classical music (classified as "highbrow") and listened to rock and/or indie music, attended gigs, played video games, watched sports, exercised or gone to the gym, used Facebook and/or Twitter, done arts and crafts, socialized at home, listened to rap music (classified as "emerging").

Alcohol and Affect Measures
The survey also requested that respondents select from a list (yes or no) those feelings that applied to them "*during the COVID-19 pandemic.*" The exact question was: *Have you felt any of the following during the COVID-19 pandemic?* Response options were fearful/anxious, depressed, more connected with people

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[1] Available online at: https://medium.com/@deborahalupton/timeline-of-covid-19-in-australia-1f7df6ca5f23 (Note: COVID-19 was declared a pandemic on March 11, 2020).

Class label	Economic capital		Social capital		Cultural capital
	Household income	Assets (property and savings)	Known social contacts	Prestige of social contacts	Emerging cultural activities
Working	1.89	1.50	1.23	1.36	2.17
New worker	2.58	1.71	3.72	4.23	2.84
Emerging middle	2.15	1.50	1.53	4.84	2.22
Established middle	3.02	4.31	1.31	1.42	2.40
New middle	2.17	1.56	3.90	2.56	2.48
Emerging affluent	3.40	4.29	2.58	4.73	2.30
Established affluent	3.55	4.37	4.36	3.40	3.05

(e.g., *via* social media or with neighbors/local community), isolated/lonely, hopeful about the future, a reduced sense of control, pessimism about the future, uncertainty.

Alcohol consumption patterns were measured using the 3-item Alcohol Use Disorder Identification Test—Consumption (AUDIT-C), which provides a total score out of 12 and allows determination of "problematic" alcohol consumption according to frequency and quantity consumed. The AUDIT-C tool has been validated for use in the general population (21, 23). An AUDIT-C score of 4 or above is considered indicative of problematic drinking (based on health and/or safety).

The second survey repeated only the alcohol questions and the measures of reactions to the pandemic. Respondents took 3–5 min to complete each survey.

Ethics and Consent

The study was approved by the (redacted for review). The first page of each survey described the study in full including contact details for the research team and explaining that respondents had been invited to complete two surveys. Respondents provided consent by selecting "yes" to a series of conditions at the beginning of the survey, and for their de-identified responses to be used for research, per the Australian National Statement on Ethical Conduct of Human Research (24).

Analytic Methods

We analyzed data in several steps. We began with the outcome of Latent Class Analysis (LCA), outlining the different sub-groups of women distinguishable by marginal mean scores for the five measures indicating compositions of economic, social and cultural capital (see **Table 1**). We then described and labeled each of the social class groups based on responses at time point 1; $N = 1,218$ (**Table 2**). The social class groups were differentiated by their access to different compositions of capital and these are graphically depicted on two axes comprising economic (x axis) and social capital (y axis) (**Figure 1**). Once the social classes and the composition of capitals that characterize them were determined, we conducted Chi-square tests of independence, Fisher's exact-test or Kruskal-Wallis-test were performed as appropriate to explore the relation

between social class and changes in affect and social class and AUDIT-C score. Change in responses across the two time points ($N = 799$ respondents completed both surveys) (see **Table 3**) was categorized into: no change, increase or decrease. To examine the relation between social class and the categorical variable indicating change across time for the variables of interest (affect and AUDIT-C score) a Chi square-test of independence was performed.

LCA: Identifying Social Classes

We applied LCA to survey questions pertinent to the calculation of social class asked at time point 1. This approach allowed us to create social class groups that could be compared on their affective states and alcohol consumption patterns at each of the two survey time points during the COVID-19 pandemic. The number of classes was determined using both AIC (Akaike Information Criterion) and BIC (Bayesian Information Criterion). As described earlier, we adopted Sheppard and Biddle's (15) framework [a replication of Savage et al.'s study (14)] for determining social class, which they validated in Australia with a probability survey sample of 1,200 adults aged 18 years and over.

To ensure that the measures of capital had similar ranges while maintaining their distribution, they were transformed into quintiles before being entered into the final model. In our sample the variable associated with "highbrow" activities were highly skewed, and it was not possible to obtain quintiles and to include it in the LCA. Consequently, there was only one measure of cultural capital in our analysis (those considered to be "highbrow"), meaning not all types of capital had equal weighting in the final social class model. This is a point of difference with two previous studies that have used this framework (i.e., Sheppard and Biddle's study and that conducted by Savage et al.), in which the forms of capital have equal weighting in the final model.

Social classes are labeled and described based on the volume and composition of the various forms of capital characterizing each class by differences between the marginal means. Respondent's demographic details, specifically, education and living arrangements were included in the class descriptions as additional contextual information or "points of difference" where it helped to distinguish between groups.

TABLE 2 | Summary of social classes resulting from LCA: labels and descriptions.

Class label	Description
Working	Members of the "working" class, comprising 22.9% of the sample ($n = 279$), have the **lowest of all forms of capital** and thus the **fewest resources and advantages** of all the classes. Members of this class report the *lowest income* and *fewest property and cash savings assets*. They also report the *fewest social contacts*, and their *known social contacts* are those with the *lowest occupational prestige*. Rates of educational attainment are lowest in the "working" class. Members comprising this class are the least likely of all classes to have completed University or College (20.8% reported completing University or College). They are the most likely of all classes to have achieved High/Secondary school as their highest level of education completed (53.4%) compared to other classes (which ranged from 18.2% of the "emerging affluent" class as the lowest to 36.4% of the "new middle" class as the next highest). Members of the "working" class had the *lowest participation in emerging cultural activities*. Members of this class are also most likely to be renting (30.3% of the overall sample) compared to other classes. This class are most likely to be living alone and most likely to be unemployed compared with other classes.
New worker	Members of the "new worker" class, comprising 12.3% of the sample ($n = 151$) have access to moderate income (more than the "working" class) but comparable to the "new middle" and the "emerging middle" classes, are low in property and savings assets (comparable to the "working" class). Social contacts amongst respondents comprising this class are higher than for the "working" class and not as high as scores for the "emerging middle" class. The occupational prestige of known contacts is higher than the scores for members of the "new middle" class. This class has the highest representation of respondents who reported having completed a trade certificate or apprenticeship (27.2%). Members of the "new worker" class are most likely to be working full-time than other classes.
Emerging middle	By comparison with the "working" and the "new worker" classes members of the "emerging middle" class, comprising 7.9% of the sample ($n = 97$), have more prestigious social networks (i.e., the score for occupational prestige of known contacts is higher than for the "working class"). Otherwise, members of the "emerging middle" class have access to similar amounts of economic resources as the "working" class, in fact they have slightly lower income than the "working" class but economic capital is comparable in terms of property and savings assets. Educational attainment amongst members of the "emerging middle" class is comparable to the "working" class, with members of the "emerging middle" class most likely to have completed Primary/Junior school but not have completed High/Secondary school. Unlike the "working" class, members of "emerging middle" class, while low in social contacts (like the "working" class), have social networks who work in occupations with high prestige.
Established middle	Members of the "established middle" class, comprising 9.6% of the sample ($n = 118$), report greater economic advantages (comparable the "emerging affluent" and "established affluent" classes) than the "working," "new middle," and "emerging middle" classes, but low social capital (comparable to the "working" class). This class is characterized by moderate levels of educational attainment. Members of the "established middle" class are most likely to be living with their partner and no children. They have a high representation of retirees.
New middle	Members of the "new middle" class, comprising 20.7% of the sample ($n = 253$), have low incomes and most comparable to the "emerging middle" class. They have more social contacts than members of the "emerging middle" class but their social contacts do not represent prestigious occupations like members the "emerging middle" class.
Emerging affluent	Members of the "emerging affluent" class, comprising 11.7% of the sample ($n = 143$), had amongst the highest income and assets (property and savings). Members of this class report low social contacts, but their known contacts represent occupations with high prestige. Members of the "emerging affluent" class were most likely to have completed University or College (67.8%). This class has the highest representation of retirees (along with members of the "established affluent" class) and students.
Established affluent	Members of the "established affluent" class, comprising 14.5% of the sample ($n = 177$) are the **most well-rounded in all forms of capital.** Overall, they have the **most resources and advantages** of all the classes. Members of this class are among those most likely to have completed University or College (60.5%) (comparable with the emerging affluent class). They have the highest participation in emerging cultural activities. Members of this class are most likely to be living with a partner and with children and a high representation of retirees.

Table 1 below indicates the marginal means for each of the seven social classes. These are then plotted in **Figure 1** to illustrate different compositions of social and economic capital, and their "position in social space" relative to each other. Noting that participation in "emerging" cultural activities was about the same for all classes except for the "established affluent" class—members of this class reported slightly higher cultural capital.

Table 2 provides the social class labels and describes each class according to the composition of the various forms of capital that characterize the subgroup. Respondent's demographic details, specifically, education and living arrangements were included in the class descriptions as additional contextual information

or "points of difference" where it helped to distinguish between groups. The descriptions provided in the social class models by Savage et al. (14) and Sheppard and Biddle's (15) models were guides.

RESULTS

Responses summarizing changes in affect and alcohol consumption and how these differ between social class groups at time point 1 are first provided (see **Table 4**) allowing for a "baseline." We then present select results where change was
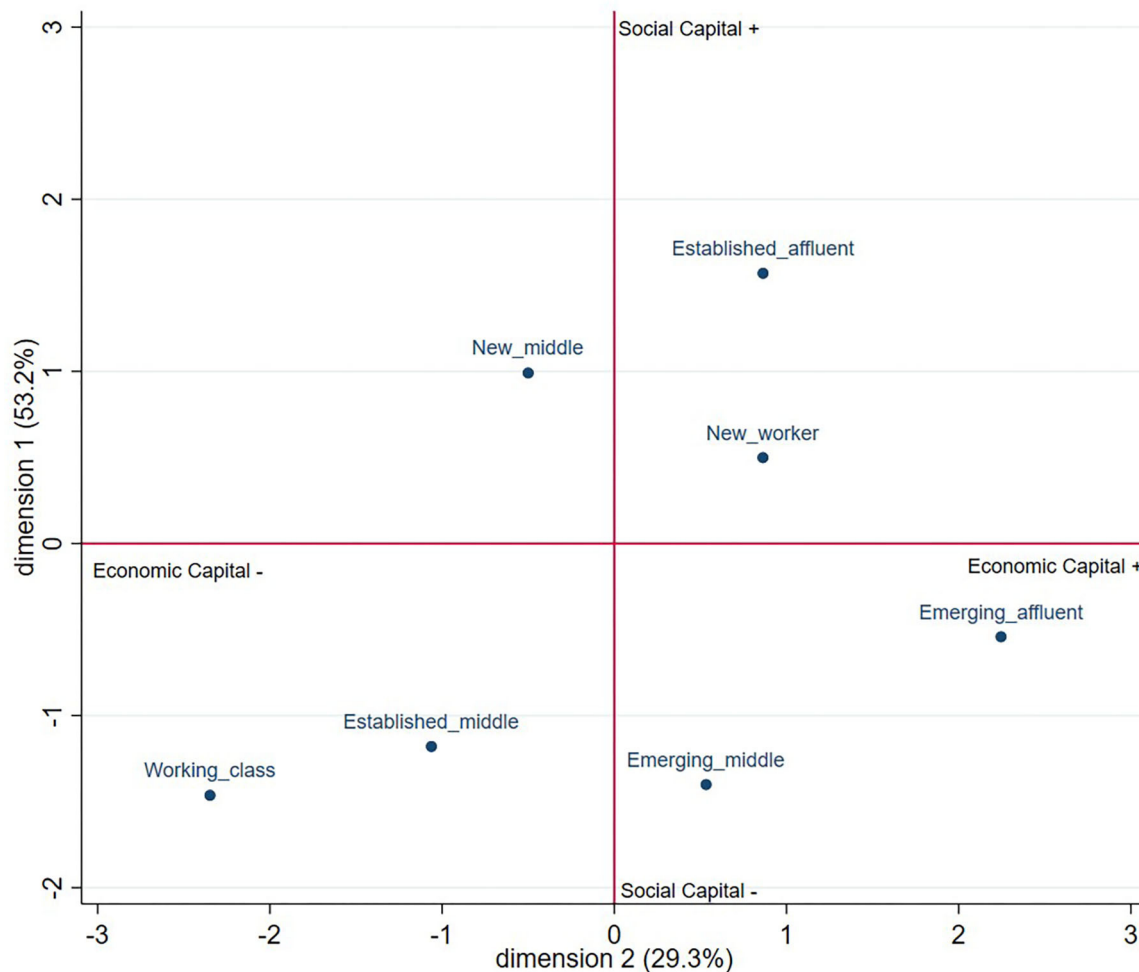
FIGURE 1 | The position of social classes in social space by economic and social capital.

observed between survey time point 1 and 2, differentiating type and prevalence of change by social class group (see **Table 5**). We detail only changes in affect variables that were statistically significant between social classes—that is, changes in feeling fearful or anxious, depression and uncertainty. We then outline changes in alcohol consumption patterns by social class, we offer some insight to the potential relationship between the reported changes by comparing the type of change (increase/decrease) in affect and change in alcohol consumption (increase/decrease in AUDIT-C scores), looking for patterns.

Respondent Characteristics

A total of 799 (65%) respondents completed both surveys. The following results report responses from women who completed surveys at time points 1 and 2. Age, education and social class were not predictors that respondents of the first survey (time point 1) would complete the second survey (time point 2).

Affect and Alcohol Patterns at Time Point 1 by Social Class

Table 4 and **Figure 2** depict the changes in affect and alcohol consumption patterns at time point 1 (including only respondents who completed both surveys, $N = 799$). This is useful context for interpreting change between survey time points.

Statistically significant differences between social class groups at time point 1 were observable in four of the eight feelings— "fearful/anxious" "depression," "uncertainty," and "reduced sense of control" all reactions that show negative affect.

Table 4 shows that at time point 1, the "emerging middle" class was the most likely to respond "yes" to feeling fearful or anxious (52.7%) compared to other classes, particularly compared to the "established middle" class (27.3%). The "emerging middle" class was the most likely to report "yes" to feeling "uncertainty," compared to the "working" class which was most likely to respond "no" to feeling uncertainty (52.0%). The "emerging middle" class was most likely to

TABLE 3 | Respondent characteristics.

	Working N = 175	New worker N = 104	Emerging middle N = 55	Established middle N = 88	New middle N = 163	Emerging affluent N = 97	Established affluent N = 117
Age, median (IQR)	55.0 (50.0, 60.0)	54.0 (48.0, 58.0)	55.0 (50.0, 60.0)	55.5 (50.0, 59.0)	54.0 (49.0, 59.0)	55.0 (50.0, 59.0)	53.0 (48.0, 59.0)
Education level							
Up to high/secondary school	101 (57.7%)	26 (25.0%)	19 (34.5%)	33 (37.5%)	61 (37.4%)	16 (16.5%)	36 (30.8%)
Trade certificate or apprenticeship	40 (22.9%)	30 (28.8%)	17 (30.9%)	22 (25.0%)	41 (25.2%)	15 (15.5%)	16 (13.7%)
University or college	34 (19.4%)	48 (46.2%)	19 (34.5%)	33 (37.5%)	61 (37.4%)	66 (68.0%)	65 (55.6%)
Savings							
<$20 k	114 (80.3%)	77 (79.4%)	34 (73.9%)	10 (12.8%)	102 (73.9%)	21 (24.1%)	22 (21.0%)
$20–40 k	13 (9.2%)	8 (8.2%)	5 (10.9%)	13 (16.7%)	17 (12.3%)	6 (6.9%)	22 (21.0%)
$40–$60 k	3 (2.1%)	5 (5.2%)	1 (2.2%)	7 (9.0%)	4 (2.9%)	17 (19.5%)	10 (9.5%)
$60–80 k	1 (0.7%)	0 (0.0%)	0 (0.0%)	4 (5.1%)	5 (3.6%)	6 (6.9%)	5 (4.8%)
$80–100 k	1 (0.7%)	0 (0.0%)	4 (8.7%)	9 (11.5%)	1 (0.7%)	12 (13.8%)	4 (3.8%)
$100–150 k	5 (3.5%)	0 (0.0%)	0 (0.0%)	4 (5.1%)	3 (2.2%)	9 (10.3%)	14 (13.3%)
$150 k plus	5 (3.5%)	7 (7.2%)	2 (4.3%)	31 (39.7%)	6 (4.3%)	16 (18.4%)	28 (26.7%)
Property value							
<$250 K	24 (21.6%)	10 (10.9%)	7 (20.0%)	0 (0.0%)	25 (18.2%)	0 (0.0%)	0 (0.0%)
$250–500 K	56 (50.5%)	34 (37.0%)	16 (45.7%)	0 (0.0%)	57 (41.6%)	1 (1.2%)	0 (0.0%)
$500–1 million	31 (27.9%)	47 (51.1%)	12 (34.3%)	38 (52.1%)	49 (35.8%)	37 (44.6%)	38 (36.5%)
1 million or more	0 (0.0%)	1 (1.1%)	0 (0.0%)	35 (47.9%)	6 (4.4%)	45 (54.2%)	66 (63.5%)
Renting	39 (26.0%)	7 (7.1%)	13 (27.1%)	7 (8.8%)	14 (9.3%)	8 (8.8%)	3 (2.8%)
Household income							
<$20,000	27 (15.7%)	5 (4.8%)	3 (5.5%)	2 (2.3%)	5 (3.1%)	0 (0.0%)	1 (0.9%)
$20,000 to <40,000	49 (28.5%)	8 (7.7%)	7 (12.7%)	9 (10.2%)	26 (16.0%)	3 (3.1%)	3 (2.6%)
$40,000 to <60,000	33 (19.2%)	23 (22.1%)	14 (25.5%)	5 (5.7%)	37 (22.7%)	5 (5.2%)	6 (5.1%)
$60,000 to <80,000	33 (19.2%)	14 (13.5%)	9 (16.4%)	5 (5.7%)	33 (20.2%)	13 (13.4%)	11 (9.4%)
$80,000 to <100,000	17 (9.9%)	23 (22.1%)	12 (21.8%)	14 (15.9%)	23 (14.1%)	19 (19.6%)	21 (17.9%)
$100,000 to <150,000	10 (5.8%)	23 (22.1%)	8 (14.5%)	27 (30.7%)	32 (19.6%)	35 (36.1%)	44 (37.6%)
$150,000 or more	3 (1.7%)	8 (7.7%)	2 (3.6%)	26 (29.5%)	7 (4.3%)	22 (22.7%)	31 (26.5%)
Living alone	47 (26.9%)	18 (17.3%)	6 (10.9%)	11 (12.5%)	32 (19.6%)	18 (18.6%)	10 (8.5%)
Number of children living with respondent, median (IQR)	2 (1, 2)	2 (1, 2)	1.5 (1, 2)	2 (1, 2)	2 (1, 2)	2 (1, 2)	2 (1, 2)
Paid work	83 (47.4%)	81 (77.9%)	38 (69.1%)	54 (61.4%)	118 (72.4%)	70 (72.2%)	92 (78.6%)
Full time work	38 (21.7%)	48 (46.2%)	19 (34.5%)	28 (31.8%)	53 (32.5%)	42 (43.3%)	45 (38.5%)

Percentages may not total 100 due to rounding.

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TABLE 4 | Affect and alcohol patterns at time point 1 by social class (*n* = 799).

	Working	New worker	Emerging middle	Established middle	New middle	Emerging affluent	Established affluent	*p*-value
Fearful or anxious								0.031
No	107 (61.1%)	58 (55.8%)	26 (47.3%)	64 (72.7%)	97 (59.5%)	65 (67.0%)	64 (54.7%)	
Yes	68 (38.9%)	46 (44.2%)	29 (52.7%)	24 (27.3%)	66 (40.5%)	32 (33.0%)	53 (45.3%)	
Depression								0.046
No	144 (82.3%)	79 (76.0%)	38 (69.1%)	76 (86.4%)	118 (72.4%)	75 (77.3%)	84 (71.8%)	
Yes	31 (17.7%)	25 (24.0%)	17 (30.9%)	12 (13.6%)	45 (27.6%)	22 (22.7%)	33 (28.2%)	
More connected with people								0.15
No	149 (85.1%)	84 (80.8%)	49 (89.1%)	80 (90.9%)	131 (80.4%)	79 (81.4%)	91 (77.8%)	
Yes	26 (14.9%)	20 (19.2%)	6 (10.9%)	8 (9.1%)	32 (19.6%)	18 (18.6%)	26 (22.2%)	
Isolated/lonely								0.33
No	128 (73.1%)	68 (65.4%)	37 (67.3%)	69 (78.4%)	108 (66.3%)	72 (74.2%)	82 (70.1%)	
Yes	47 (26.9%)	36 (34.6%)	18 (32.7%)	19 (21.6%)	55 (33.7%)	25 (25.8%)	35 (29.9%)	
Hopeful about the future								0.45
No	135 (77.1%)	80 (76.9%)	47 (85.5%)	67 (76.1%)	136 (83.4%)	76 (78.4%)	98 (83.8%)	
Yes	40 (22.9%)	24 (23.1%)	8 (14.5%)	21 (23.9%)	27 (16.6%)	21 (21.6%)	19 (16.2%)	
A reduced sense of control								0.007
No	135 (77.1%)	60 (57.7%)	32 (58.2%)	59 (67.0%)	115 (70.6%)	62 (63.9%)	71 (60.7%)	
Yes	40 (22.9%)	44 (42.3%)	23 (41.8%)	29 (33.0%)	48 (29.4%)	35 (36.1%)	46 (39.3%)	
Pessimism about the future								0.15
No	140 (80.0%)	70 (67.3%)	40 (72.7%)	67 (76.1%)	129 (79.1%)	73 (75.3%)	81 (69.2%)	
Yes	35 (20.0%)	34 (32.7%)	15 (27.3%)	21 (23.9%)	34 (20.9%)	24 (24.7%)	36 (30.8%)	
Uncertainty								<0.001
No	91 (52.0%)	32 (30.8%)	15 (27.3%)	40 (45.5%)	45 (27.6%)	37 (38.1%)	36 (30.8%)	
Yes	84 (48.0%)	72 (69.2%)	40 (72.7%)	48 (54.5%)	118 (72.4%)	60 (61.9%)	81 (69.2%)	
Total AUDIT-C score—wave 1, median (IQR)	3 (2, 5)	3 (2, 4)	3 (2, 4)	3 (2, 5)	3 (2, 5)	3 (1, 4)	3.5 (2, 5)	0.18

Percentages may not total 100 due to rounding.

TABLE 5 | Changes in affect and AUDIT-C scores by social class group (*n* = 799).

	Working	New worker	Emerging middle	Established middle	New middle	Emerging affluent	Established affluent	*p*-value
Fearful or anxious								0.007
Less	22 (12.6%)	10 (9.6%)	15 (27.3%)	10 (11.4%)	23 (14.1%)	9 (9.3%)	25 (21.4%)	
Stayed the same	124 (70.9%)	75 (72.1%)	33 (60.0%)	61 (69.3%)	125 (76.7%)	65 (67.0%)	74 (63.2%)	
More	29 (16.6%)	19 (18.3%)	7 (12.7%)	17 (19.3%)	15 (9.2%)	23 (23.7%)	18 (15.4%)	
Depression								0.049
Less	15 (8.6%)	9 (8.7%)	6 (10.9%)	4 (4.5%)	27 (16.6%)	13 (13.4%)	19 (16.2%)	
Stayed the same	140 (80.0%)	80 (76.9%)	42 (76.4%)	77 (87.5%)	120 (73.6%)	77 (79.4%)	79 (67.5%)	
More	20 (11.4%)	15 (14.4%)	7 (12.7%)	7 (8.0%)	16 (9.8%)	7 (7.2%)	19 (16.2%)	
More connected with people								0.66
Less	15 (8.6%)	14 (13.5%)	3 (5.5%)	6 (6.8%)	17 (10.4%)	11 (11.3%)	17 (14.5%)	
Stayed the same	143 (81.7%)	77 (74.0%)	44 (80.0%)	71 (80.7%)	129 (79.1%)	71 (73.2%)	87 (74.4%)	
More	17 (9.7%)	13 (12.5%)	8 (14.5%)	11 (12.5%)	17 (10.4%)	15 (15.5%)	13 (11.1%)	
Isolated/lonely								0.69
Less	22 (12.6%)	17 (16.3%)	6 (10.9%)	10 (11.4%)	16 (9.8%)	8 (8.2%)	13 (11.1%)	
Stayed the same	125 (71.4%)	67 (64.4%)	43 (78.2%)	68 (77.3%)	123 (75.5%)	77 (79.4%)	88 (75.2%)	
More	28 (16.0%)	20 (19.2%)	6 (10.9%)	10 (11.4%)	24 (14.7%)	12 (12.4%)	16 (13.7%)	
Hopeful about the future								0.051
Less	18 (10.3%)	15 (14.4%)	4 (7.3%)	7 (8.0%)	13 (8.0%)	15 (15.5%)	10 (8.5%)	
Stayed the same	144 (82.3%)	83 (79.8%)	47 (85.5%)	77 (87.5%)	124 (76.1%)	75 (77.3%)	94 (80.3%)	
More	13 (7.4%)	6 (5.8%)	4 (7.3%)	4 (4.5%)	26 (16.0%)	7 (7.2%)	13 (11.1%)	
A reduced sense of control								0.46
Less	19 (10.9%)	15 (14.4%)	8 (14.5%)	16 (18.2%)	23 (14.1%)	16 (16.5%)	20 (17.1%)	
Stayed the same	115 (65.7%)	69 (66.3%)	39 (70.9%)	55 (62.5%)	114 (69.9%)	71 (73.2%)	79 (67.5%)	
More	41 (23.4%)	20 (19.2%)	8 (14.5%)	17 (19.3%)	26 (16.0%)	10 (10.3%)	18 (15.4%)	
Pessimism about the future								0.26
Less	19 (10.9%)	20 (19.2%)	7 (12.7%)	11 (12.5%)	15 (9.2%)	11 (11.3%)	22 (18.8%)	
Stayed the same	132 (75.4%)	64 (61.5%)	42 (76.4%)	64 (72.7%)	119 (73.0%)	69 (71.1%)	74 (63.2%)	
More	24 (13.7%)	20 (19.2%)	6 (10.9%)	13 (14.8%)	29 (17.8%)	17 (17.5%)	21 (17.9%)	
Uncertainty								0.002
Less	20 (11.4%)	14 (13.5%)	4 (7.3%)	7 (8.0%)	36 (22.1%)	16 (16.5%)	27 (23.1%)	
Stayed the same	110 (62.9%)	72 (69.2%)	45 (81.8%)	66 (75.0%)	105 (64.4%)	65 (67.0%)	71 (60.7%)	
More	45 (25.7%)	18 (17.3%)	6 (10.9%)	15 (17.0%)	22 (13.5%)	16 (16.5%)	19 (16.2%)	
AUDIT-C score								0.030
Less	47 (35.9%)	28 (31.8%)	15 (34.9%)	26 (37.7%)	23 (17.8%)	19 (22.6%)	38 (35.2%)	
Stayed the same	45 (34.4%)	35 (39.8%)	18 (41.9%)	30 (43.5%)	56 (43.4%)	41 (48.8%)	41 (38.0%)	
More	39 (29.8%)	25 (28.4%)	10 (23.3%)	13 (18.8%)	50 (38.8%)	24 (28.6%)	29 (26.9%)	

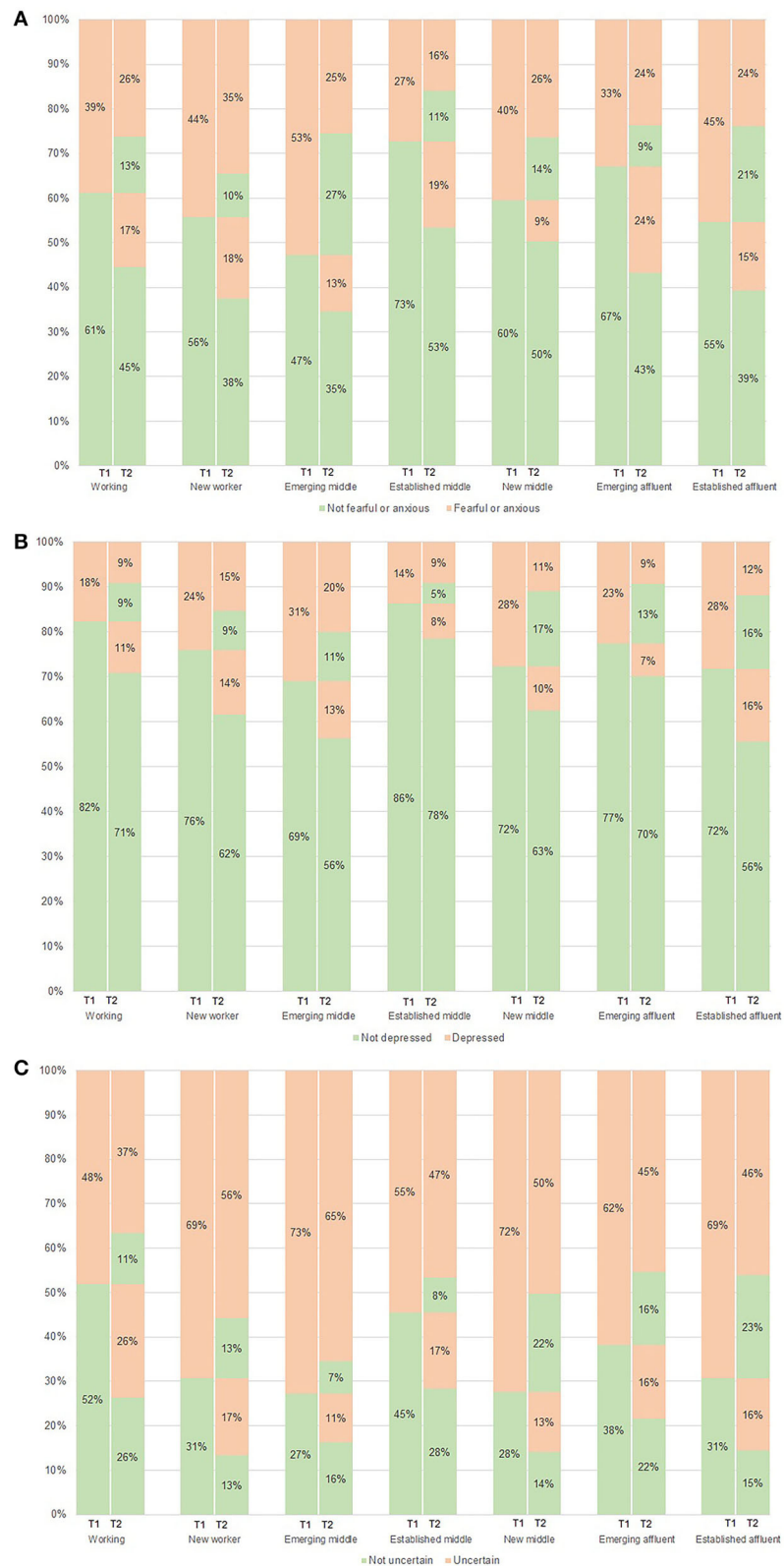*Percentages may not total 100 due to rounding.*

FIGURE 2 | Changes in negative affect between time point 1 and time point 2 during COVID-19 by social class. **(A)** Feeling fearful or anxious. **(B)** Feeling depression. **(C)** Feeling uncertainty.

report "yes" to feeling depression (30.9%) and the "established middle" was the least likely (86.4%) to respond "yes" to feeling depression.

Change in Affect Reactions and Pattern of Alcohol Consumption by Social Class

Changes in individual women's affect reactions and problematic alcohol consumption measured by AUDIT-C scores, observable as differences between social class groups, are reported in **Table 5**.

There were changes in women's responses yes/no, groupable by social class, to questions about feeling fearful or anxious and uncertainty during the pandemic—depicted in the lasagne plot below (see **Figure 2**). **Figure 2** illustrates shifts from time point 1—May 2020 (T1) to time point 2—July 2020 (T2) (i.e., increases or decreases in women's response yes/no to feelings) with change illustrated by the percentage of the sample for each social class group (25).

Notable is that there was a statistically significant difference between social classes in response to feeling a reduced sense of control at time point 1—the "working" class was most likely to respond "no" (77.1%) to feeling a reduced sense of control. The "new worker" class was most likely (42.3%) to respond "yes" to feeling a reduced sense of control. However, there was no difference between social classes when we looked for changes at survey time points 1 and 2.

Changes in Negative Affect During COVID-19 by Social Class

Changes in Feeling Fearful or Anxious Between Time Point 1 and Time Point 2 by Social Class

As shown in **Table 5**, changes in feeling fearful or anxious at time point 2 was largest in the "emerging affluent" class (23.7% of this class reported feeling "more" fearful or anxious at time point 2 than at time point 1). While only a small proportion of the "new middle" class reported feeling "more" fearful or anxious at time point 2 (9.2%), most "stayed the same" (76.7%), noting that nearly half of this class reported "yes" to feeling fearful or anxious at time point 1. **Figure 2A** shows that 40% of the "new middle" class continued to respond "yes" to feeling fearful or anxious.

As presented in **Table 5**, the "emerging middle" class was most likely to report feeling "less" fearful or anxious (27.3%). It is worth noting that at time point 1 just over half of this class (52.7%) reported "yes" to feeling fearful or anxious.

Changes in Feeling Depression Between Time Point 1 and Time Point 2 by Social Class

Table 5 shows the "established affluent" class was most likely to report feeling "more" depression (16.2%) more than any other social class. However, the "established affluent" class also reported feeling "less" depression (16.2%) alongside the "new middle" class (16.6%) more than any other class groups (noting that at time point 1, 28.2% of the "established affluent" class responded "yes" to feeling depression).

As shown in **Table 4**, the "established middle" class was the least likely to respond "yes" (13.6%) to feeling depression at time

point 1 (86.4% responded "no" to feeling depression). **Table 5** shows most of the "established middle" class reported they "stayed the same" in feeling depression (87.5%) while **Figure 2B** depicts that of the 86% who responded "no" to feeling depression at time point 1, 78% continued to report "no" at time point 2.

The "emerging affluent" class reported the lowest proportion of increase in feeling "more" depression (7.2%) at survey time point 2 (**Table 5**) and 22.7% responded "yes" to feeling depression at time point 1 (**Table 4**). **Figure 2B** shows that among those in this class reporting feeling depressed at point 1, more than half (around 57%) reported feeling less depressed at point 2 (13% of the total reporting no depression).

Changes in Feeling Uncertainty Between Time Point 1 and Time Point 2 by Social Class

As outlined in **Table 5**, the "working" class reported feeling "more" uncertainty (25.7%) the biggest increase reported at time point 2. Notable is that at time point 1, approximately half of this social class group (48.0%) responded "yes" to feeling uncertainty and 77% of these women continued to respond "yes" to feeling uncertainty at time point 2, representing 37% of the total 63% reporting depression—see **Figure 2C**.

The "emerging middle" class reported the least increase in feeling "more" uncertainty (10.9%) at time point 2. However, most of the "emerging middle" class "stayed the same" in feeling uncertainty (81.8%) this is notable given at time point 1 the "emerging middle" class reported the highest proportion who responded "yes" to feeling uncertainty (72.7%)—see **Table 4**. The large proportion of "emerging middle" class women who indicated they were feeling uncertain in both periods is clearly illustrated in **Figure 2C**, with ~89% remaining uncertain.

Similar to the "emerging middle" class, a large proportion of the "new middle" class responded "yes" to feeling uncertainty at time point 1 (72.4%)—see **Table 4**, and a large proportion "stayed the same" (64.4%) in reporting feeling uncertainty at survey time point 2—see **Table 5**. **Figure 2C** shows that ~69% of women reporting feeling uncertain at time point 1 also remained uncertain at point 2.

Changes in AUDIT-C Scores by Social Class and Relationship Between Negative Affect and Change in Alcohol Consumption

The "new middle" class reported the lowest change in terms of a decrease in AUDIT-C scores (17.8% reported a lower AUDIT-C score at time point 2—see **Table 5**). The "established middle" class showed the largest proportion of decrease in AUDIT-C scores (37.7%) followed by the "working" (35.9%) and the "established affluent" (35.2%) classes. The "established middle" class was the most likely of the social classes to report "less" in terms of AUDIT-C score (37.7%) at survey time point 2— see **Table 5**. Almost half of the "emerging affluent" class (48.8%) reported alcohol consumption patterns at time point 2 that reflected no change (i.e., "stayed the same") from time point 1.

For all classes, median AUDIT-C scores were 3 (IQ range 2–5) at time point 1, noting that a score of below 4 is considered low risk to health and safety. Exact McNemar's-tests determined

that there were no statistically significant differences in the proportions of respondents scoring in the problematic drinking range (≥4) between surveys.

Alcohol Consumption and Feeling Fearful Or Anxious

The "new middle" class was the most likely to change AUDIT-C scores toward an increase. **Table 5** shows 38.8% of this group reported increased scores and 40.5% of this group reported feeling fearful or anxious during COVID-19 at time point 1 with 76.7% reporting that their feelings in this regard remained the same at point 2.

The "emerging middle" class reported the most change in feeling "less" fearful or anxious at time point 2 (27.3%). Of the "emerging middle" class, 60% reported feeling the "same" level of fearfulness and anxiety, with the largest proportion of this group reporting feeling this way at time point 1—52.7%. A relatively large proportion of this group also reported a decrease in AUDIT-C score (for 34.9% scores were less) at time point 2—see **Table 5**. This result suggests that reduced feelings of fearfulness or anxiety might be associated with reduced alcohol consumption.

An interesting contrast is that respondents in the "emerging affluent" class, though most likely to report an increased prevalence of feeling fearful or anxious at survey time point 2 (23.7% said they felt "more" fearful or anxious), reported the second lowest change toward a reduced AUDIT-C score (22.6% reported "less" problematic alcohol consumption). The "new middle class" reported the lowest change with 17.8% reporting "less" problematic alcohol consumption.

Alcohol consumption and feeling fearful or anxious during the pandemic appear to be linked albeit with differential effects across social class groups.

Alcohol Consumption and Feeling Depression

Although the "established affluent" class was the most likely to have increased prevalence of feeling depression at time point 2 (16.2%) and more than half (67.5%) "stayed the same" (see **Table 5**), this did not seem to have a bearing on AUDIT-C scores (indicating problematic alcohol consumption). Results for the "established affluent" class showed this class either "stayed the same" (38.0%) or trended toward a decrease in alcohol consumption (for 35.2% scores were "less").

The "emerging affluent" class was the least likely to report an increased prevalence of feeling depression at time point 2 (7.2%) and almost half of the "emerging affluent" class reported alcohol AUDIT-C scores at time point 2 that reflected no change (48.8% "stayed the same"). There does not appear to be a relationship between feeling depression and change in AUDIT-C scores for the "emerging affluent" class.

Alcohol Consumption and Feeling Uncertainty

The "new middle" class reported the largest proportion of increase in AUDIT-C scores (38.8%)—see **Table 5**. The "established middle" class showed the largest proportion of decrease in AUDIT-C scores (37.7%) followed by the "working" class (35.9%)—see **Table 5**. The "working" (25.7%), "new worker" (17.3%), and "established middle" (17.0%) classes experienced

the most increase in feeling "more" uncertainty during COVID-19—see **Table 5** and **Figure 2**. There did not appear to be a clear relationship between increased uncertainty and increased AUDIT-C score, but together these classes constituted the largest part of the increase in feeling uncertainty and also collectively contributed to the largest proportion of increase in AUDIT-C scores.

DISCUSSION

In this paper we address the question, *does social class differentiate change in affect and change in alcohol consumption patterns during COVID-19?* We tested the proposition that the impacts of the pandemic would be felt differently, in terms of change in affect and alcohol consumption patterns, by women in different social class groups in Australia. The various pandemic countermeasures experienced in Australia have placed restrictions on women's social life, with cultural and economic impacts that manifest in their differing affect reactions in our study. Our results underscore the salience of a complex model of social class that recognizes the interplay of economics, culture, and social aspects of opportunity that distinguish groups of people (26–28). This sophisticated model of social class has uncovered subtle nuances in women's affect reactions and alcohol consumption that would be otherwise unnoticed. Our results show very distinct differences in how particular groups of women (comprising the mid-life study population) reacted to COVID-19—in terms of affect states and alcohol consumption and we can identify groups who experienced the pandemic in more fraught and "problematic" ways. Setting our results within a social class framework, we can also interpret how affect reactions during the pandemic are moored in class distinctions, reflecting the symbolic dimensions of class characteristics. We found feeling more fearful or anxious was most prominent amongst women in the "emerging affluent" class (who reported feeling more fearful or anxious at timepoint 2 than any other class group). The "working" class was the most likely to experience an increase in feeling uncertainty. The "established affluent" class was the most likely to report an increase in feeling depression during COVID-19, while the "emerging affluent" and the "established middle" was the least likely.

A potential relationship between AUDIT-C score (problematic alcohol consumption) and negative affect between social classes observable through our study extends recent studies produced during COVID-19 that point to links between social distancing restrictions, increased mental health burden (3) and particularly relevant here, to increased frequency of alcohol consumption amongst Australian women (11). The "new middle" class who reported feeling fearful or anxious and reported the largest proportion of increase (and lowest change in terms of a decrease) in AUDIT-C scores points to a potential relationship between alcohol consumption and this negative affect reaction during COVID-19. There was no such relationship observed for problematic alcohol consumption and feeling uncertainty or depression. Although, we also know that not all women respond to crisis in the same way, and nor do they consume alcohol for

the same reasons. From our previous research, we identified that mid-life women consume alcohol to cope with stress manifest in myriad forms (9, 10, 29), and pandemic countermeasures have increased the magnitude of stress in women's lives (30). This was echoed in our results presented herein, which show respondents in the "emerging affluent" class, for example, though most likely to report an increase in feeling fearful or anxious, reported unchanged AUDIT-C score between survey time points. To add further classed complexity, results from the "emerging middle" class suggests that reduced feelings of fearfulness or anxiety might be associated with reduced alcohol consumption. We have ascertained that the potential relationship between changes in negative affect and change in AUDIT-C scores during COVID-19 are not uniform for all Australian women comprising our sample.

The economic and social structure of the social world experienced an upheaval during COVID-19 lockdown restrictions impacting on work and employment conditions, with the potential to compromise one's "sense of place" in the world. This disruption compromises one's ability to practice what Durkheim referred to as "logical conformity" (31) in an effort to conserve social order. Using our study results, we can consider how the aspects of life that identify social classes, and women's sense of belonging within them, as well as class-based aspirations that distinguish social classes, might be jeopardized during the pandemic. Savage (32) explored the meanings of work and discussed the role that work or being employed takes in enhancing confidence, and to bolster class position—improving privilege and power. This sense of jeopardy perhaps exacerbates feelings of anxiety, fear, uncertainty, and depression, among some women more so than among others, depending on social class. For example, increased fear and anxiety during COVID-19 in our study population was observed most amongst the "emerging affluent" class. This class have the highest income and assets (property and savings)—comparable only to the "established affluent" class (high access to all types of capital)—of all social class groups. Women in this class are also highly educated, and although they report low social contacts, social networks extend to occupations with high occupational prestige. It could be that feeling fearful or anxious during COVID-19 is heightened for women in this social class through the risk of losing income or reduced asset values. The potential dismantling of the economic capital on which their social identity is being established, and restrictions on social life including limitations on forming new social relationships thus reducing opportunities for their existing (valuable) social capital to be used to improve social class status possibly perpetuates feelings of fear and anxiety. The COVID-19 crisis has shaped many aspects of women's everyday lived experience (30), with the potential to re-order social life as they knew it, and in doing so, disrupting their classed identities. We can interpret this in our results, which show that at the outset of the pandemic, half of the "emerging middle" class reported feeling fearful and anxious, and more than half said this stayed the same when surveyed during the pandemic. This class group, with low economic capital but high social capital characterized by social contacts with high

levels of prestige, likely experienced limits on participating in the reassuring and symbolic dimensions of socializing—perhaps evoking anxiety as they found themselves descending into tedium and fear. To summarize, our results demonstrate that though different women comprising the mid-life study population all experienced fear and anxiety, the underpinning was not uniform across social groups—rather it was discernible by social class.

Of those we surveyed, women in the "established affluent" class increased prevalence of feeling more depression than any other social class. Notably this class also decreased prevalence of feeling depression more than any other class group (similarly to the "new middle" class). This suggests the temporal aspects of living through the pandemic, and perhaps as time went on, an increasing sense of risk and limitations of the pandemic, might have impacted on an increasing negative "depressive" affect within members of this group. Recent research suggests comparative optimism about COVID-19 (perceived risk of infection and recovery) is weaker during uncontrollable events (33). Responsibility is situated with individuals during COVID-19 distancing measures in Australia—the efficacy of public health measures relies on individual choices to "stay at home" and "do the right thing" and there is a moral significance to class theorized in social class literature (34). Combined, this suggests that different levels of responsibility would be inordinately felt by women in different social class positions during COVID-19. Perhaps the weight of moral responsibility imbued in their class identity lead the "established affluent" to report feeling more depression during the pandemic. This is interesting given the "established middle" class and the "emerging affluent" class were the most likely to report feeling less depression during the pandemic. Perhaps women in these groups had simply experienced "crisis fatigue" (35) and had "brought down their shutters" (35) resulting from the omnipresence of fear and uncertainty, displaying a level of acceptance of having no control (36). Albeit, the "established middle" class also had the amongst the highest representation of retirees, for whom being at home during lockdown restrictions meant no changes to work routines and might not be all that different to previous life.

With respect to feeling uncertainty during COVID-19, the "working" class experienced the largest increase. It is unsurprising that the "working" class were identified as experiencing uncertainty during the pandemic, given the reported lowest income and fewest property and cash savings/assets among women in this class group. Though we do not know specific job titles, low wage work is often precarious work particularly during pandemic conditions, with leave unpaid and little to no job security. This, coupled with poor access to resources *via* social contacts, might account for the highest level of uncertainty in this social class (37). Shilling and Mellor (38) describe conditions of "future-oriented reflexivity" with relevance to understanding the preconditions of uncertainty. They explain that being "future oriented" and having the ability to foresee and adopt to situations with new patterns of action are limited by structural factors as well as by agency. It is entirely

possible that structural determinants shaped by social class impact the ability for women in the "working" class to be future oriented in turn increasing feelings of uncertainty during COVID-19.

STRENGTHS AND LIMITATIONS

A key strength of our study is the social nuances between groups of mid-life women that our model of class illuminates by capturing diversity in reactions and behavior during COVID-19. These would be otherwise undetected if interpreted at a whole of population level. Women who shared similar social "space" in terms of their class characteristics relative to those possessed by other women, likely also share pandemic experiences, but these are subtle and would be difficult to detect if only economic or education were used as predictors of outcomes.

There are several limitations with the method employed for our study. In terms of the replicability of our social class model, our measure of cultural capital excluded high-brow cultural activities meaning not all capitals had equal weighting in the final model. This is a point of difference to the social class model used by Sheppard and Biddle (15) and is a potential theoretical limitation of our analysis. With respect to our sample, there are several limitations. Due to the nature of our online survey (per social distancing), our sample does not encompass Australian women who do not access digital technologies. We also did not sample for Aboriginal and Torres Strait Islander or ethnic minority groups, groups identified as particularly vulnerable to the health effects and, social/economic impacts of COVID-19. Also, the sample size comprising each of the social class groups ($\sim$200 per group) was too small to determine if statistical changes observed within social classes in negative affect correlated with changes in alcohol consumption.

CONCLUSION

Comparisons in three negative reactions (both increases and decreases between time points) for "fearful / anxious," "uncertainty," and "depressed" and patterns of alcohol consumption between social class groups of women at two time points during COVID-19 are provided herein. Our findings identify where particular attention should be paid in future public health responses, toward certain sub-populations of women likely to fare worst through the pandemic. Our work has relevance for designing future public health responses to COVID-19 and into recovery phases of the pandemic segmented by population groups. Our study shows this sophisticated,

multi-dimensional model has substantial advantage over less dynamic ways of interpreting disadvantage in pandemic outcomes based on unidimensional measures such as education or income alone. Material inequality is entirely relevant to COVID-19, and the social determinants of health shaping COVID-19 disparities warrants identification as far as disease transmission and economic impacts are concerned (5). However, class formations situated in the social and cultural aspects of opportunity are also tremendously relevant, given the nature and magnitude of social disruption as a by-product of pandemic countermeasures in Australia, and the flow on effect for adverse coping behaviors, like alcohol consumption. We can link such differences between groups of mid-life women to the characteristics manifest in their social class position within our broader population sample—to differences in life chances represented in compositions of economic, social and cultural capital and to the values embedded in their social class conditions.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Flinders University Social and Behavioral Research Ethics Committee. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

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COVID-19, Alcohol Consumption and Stockpiling Practises in Midlife Women: Repeat Surveys During Lockdown in Australia and the United Kingdom

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Introduction: This project examined the impact of COVID-19 and associated restrictions on alcohol practises (consumption and stockpiling), and perceptions of health risk among women in midlife (those aged 45–64 years).

Methods: We collected online survey data from 2,437 midlife women in the United Kingdom (UK) and Australia in May 2020, recruited using a commercial panel, in the early days of mandated COVID-19 related restrictions in both countries. Participants were surveyed again (N = 1,377) in July 2020, at a time when COVID-19 restrictions were beginning to ease. The surveys included the Alcohol Use Disorder Identification Test—Consumption (AUDIT-C) and questions alcohol stockpiling. Analysis involved a range of univariate and multivariate techniques examining the impact of demographic variables and negative affect on consumption and acquisition outcomes.

Results: In both surveys (May and July), UK women scored higher than Australian women on the AUDIT-C, and residence in the UK was found to independently predict stockpiling of alcohol (RR: 1.51; 95% CI: 1.20, 1.91). Developing depression between surveys (RR: 1.53; 95% CI: 1.14, 2.04) and reporting pessimism (RR: 1.42; 95% CI: 1.11, 1.81), and fear/anxiety (RR: 1.33; 95% CI: 1.05, 1.70) at the beginning of the study period also predicted stockpiling by the end of the lockdown. Having a tertiary education was protective for alcohol stockpiling at each time point (RR: 0.69; 95% CI: 0.54, 0.87).

Conclusions: COVID-19 was associated with increases in risky alcohol practises that were predicted by negative emotional responses to the pandemic. Anxiety, pessimism and depression predicted stockpiling behaviour in UK and Australian women despite the many demographic and contextual differences between the two cohorts. Given our findings and the findings of others that mental health issues developed or were exacerbated during lockdown and may continue long after that time, urgent action is required to address a potential future pandemic of alcohol-related harms.

Keywords: COVID-19, alcohol, midlife women, health perception, survey

INTRODUCTION

The Coronavirus Disease (COVID-19) pandemic has now been active for 1 year, at the time of writing having passed 63 million cases and causing at least 15 million deaths globally (1). Rapid transmission of the virus is due to the very high susceptibility of the population (2) and, although the majority of those infected will experience only mild symptoms (if any), the sheer number of global infections has resulted in a high absolute number of deaths and serious, and often prolonged complications related to infection (3)—particularly in vulnerable population groups such as the elderly and those with underlying comorbidities (4). Further, the impact of COVID-19 extends beyond physical health; the economic impacts of the pandemic have been considerable and borne disproportionately by already economically disadvantaged countries and population groups (5).

The rapid spread of COVID-19, which had involved all continents but Antarctica (6), has led to a wide range of public health responses around the world. The majority of the more effective responses have included measures that isolate and quarantine those infected and their close contacts, and restrict social interaction among the population by closing businesses, school and universities and closing national, and state and territory borders. The extent of curfews and wide-spread community lockdowns of various levels of stringency has varied in scope and date of implementation across and within countries (7). The individual and social costs of these restrictions have been the subject of concern, particularly in the area of mental health and reductions in preventive care for non-COVID-19 health conditions such as breast cancer (8–11). For instance, there was a 30% reduction in mammograms conducted through BreastScreen Australia's program between January and June in 2020 relative to the same time in the previous reporting period (12).

In ongoing investigations, using diverse methods, our team is exploring the way that midlife women, defined here as those aged 45–65 years, understand and negotiate the breast cancer risk associated with alcohol consumption. The use of alcohol is high in these women relative to other age groups, as is the incidence of breast cancer in Australia (13–16). There are many health impacts attributable to alcohol, which the World Health Organization estimates directly contributes to more than 200 health conditions including injury, mental health disorders, strokes and cardiovascular disease (17). In Australia in 2010, the social cost of alcohol (productivity, health resources, and criminal justice system combined) was estimated to be more than 14 billion Australian dollars (18)—nearly 13 USD in 2010. As is discussed by Milic et al. (19), women are more susceptible than men to the many health impacts of alcohol and also more likely to develop alcohol disorders. Alcohol has a dose-response relationship with the development of breast cancer, and has been identified as the biggest modifiable risk factor for breast cancer globally (20). Our work suggests that alcohol consumption in midlife women is mediated by both external and internal factors including socioeconomic status, work and societal role pressures, coping styles, and risk perceptions (14, 15, 21). A further significant stressor in midlife women are the psychological, emotional, physical and role transitions occurring throughout the perimenopausal period (19, 22). Within this period, menopause is associated with an array of distressing symptoms that have a substantial effect on quality life occurring at an age (global average 46–52 years) when many women remain engaged in work, are actively childrearing and have other caring responsibilities (23). The physiological changes and psychological distress associated with menopause are thought to be pivotal in the convergence of male and female alcohol consumption in midlife (19). Women have described using alcohol to assist in achieving happiness and negotiating unhappiness over the life course (14), with acute risks and stressors more strongly associated with alcohol consumption, and any changes to consumption, than the longer term potential risk of breast cancer (15).

The pandemic represents a potential modifier of alcohol behaviour and perceptions of the longer-term risk of breast cancer, particularly in the presence of a new and more immediate health risk. In our recent qualitative analyses, we describe how the risk horizons of midlife women contract from the uncertainties of the longer-term and refocus on the more pressing need to "get through" the pandemic (21). In the context of the COVID-19 lockdowns, it has been reported that women have increased their frequency of alcohol consumption in Australia, with managing stress being the most commonly reported reason (24). Australian data from May 2020, collected amidst the first COVID-19 outbreaks, indicated that a higher proportion of females than males (18% compared to 16%) increased alcohol consumption at this time (25). Similar reports of increases in alcohol consumption have been made in other Westernised counties, including those comprising the United Kingdom –UK (26). This raises the questions of whether changes in women's alcohol behaviours in response to COVID-19 lockdowns are driven by similar factors across countries; if those drivers remain the same or differ from those identified pre-COVID-19; and whether perceptions of short and long-term health risks have been influenced by COVID-19 related lockdowns.

This project aimed to examine the impact of COVID-19 on midlife women's alcohol consumption and their perceptions of health risk. We undertook two surveys in two countries known to have similar sociality (i.e., levels of acceptance and social norms) and cultural practises with respect to alcohol consumption (27, 28). The first survey was implemented at a time of uncertainty and potentially high anxiety due to rising COVID-19 case numbers in both countries. The second survey was implemented two months later, by which time some personal and social adaptation to the situation may reasonably have been expected, case numbers had reduced, and many social restrictions were beginning to lift in both countries. This is with the exception of Victoria, an Australian jurisdiction that was re-introducing a second lockdown in response to a local outbreak at the time of the second survey in July after a period of reduced restrictions (29).

COVID-19 cases appeared earlier in the UK relative to Australia, however by May 2020, associated lockdowns were implemented in both countries with their populations, excluding "frontline" workers, restricted in their movements (3, 30). The

number of COVID-19 cases was very much higher in the UK than Australia, with confirmed cases reaching ~233,000 and 7,300 respectively by May 2020 (31). Despite this, at that time, both countries were rated at around 75 in the Oxford Stringency Index, which is a score derived from the existence of 18 indicators of government responses such as school closures and travel restrictions (32, 33). By July 2020, restrictions were just beginning to be lifted in both countries, with pubs and restaurants starting to open and with fewer mobility restrictions, although legal requirements for social distancing and associated travel limitations remained. At this time, the Oxford Stringency Index was ~65 in Australia and in the UK (33).

Data from our surveys therefore provide insight into critical points of interest: how Australian and British women's alcohol consumption changed over time during COVID-19 in relation to their perceptions of health risks.

MATERIALS AND METHODS

We conducted online surveys with 1,218 midlife women in Australia and 1,219 United Kingdom (UK) in May 2020. Participants were surveyed again (799 in Australia and 578 in the UK) in July 2020. The study was approved by the Flinders University Human Research Ethics Committee.

Participants

The participants were recruited via a commercial panel provider, Qualtrics. The company used a quota system to recruit women aged 45–64 years with evenly distributed tertiles of household income based on ABS definitions of "low," "medium," and "high" (34) as determined by the most recent Census data for each country. Women with existing chronic conditions were ineligible for participation in the survey. Women identifying in this group were excluded on their response to the question "Do you currently suffer from any chronic illnesses?" and the advice that a chronic condition is "…a human health condition or disease that is persistent or otherwise long-lasting in its effects or a disease that comes with time. E.g., Diabetes, Heart Disease, Arthritis." This group was excluded due to the potential impact that ongoing chronic health issues might have on drinking behaviours, engagement with the workforce and household and personal income. After two months, the same participants were invited to participate in a second survey. We estimated that we would need to recruit 1,200 women in each country (i.e., 2,400 participants in total) assuming that proportional estimates were approximately normally distributed and based on a precision of 4% with confidence intervals of 95%, and on the basis of an anticipated 50% attrition at follow-up (on advice from Qualtrics). Participants were provided with a non-monetary reimbursement in the form of loyalty points or vouchers (depending on the sample source) at survey completion. The reimbursement was approximately equivalent to Australian minimum wage pro-rata to survey length (~15 min).

Surveys

In May 2020, participants in Australia and the UK completed the first online survey. The survey landing page described the study in full, explaining that individuals would be invited to respond to two surveys. The landing page also contained contact details of the research team and, consistent with the Australian National Statement on Ethical Conduct of Human Research (35), participants acknowledged having read the information and indicated their consent before proceeding with the survey. We collected a range of demographic and living arrangement information: age, relationship status, parenting status and number of children living at home, respondent education level, household and personal income, and post-code. Participants provided information on their usual employment status and whether their work status or conditions had changed because of social restrictions imposed as part of the public health response to COVID-19.

Pattern of alcohol consumption was measured using the Alcohol Use Disorder Identification Test-Consumption (AUDIT-C), which provides a total score out of 12 across three categories of drinking frequency and quantity and has been validated for use in a range of general populations (36, 37). In addition, participants were asked if alcohol patterns had changed during the pandemic and, if so, in what way (e.g., more frequently, more volume, to pass time, and other options). Information about online alcohol purchasing and context of drinking (alone or in company) was also collected. Participants were asked about taking measures to ensure access to alcohol such as buying more than usual, here defined as "stockpiling."

As well as general health status (Overall, how would you rate your general health?—very good/good/moderate or fair), participants were asked about their status with regard to COVID-19 infection (ever diagnosed or suspected—yes/no), and history of breast cancer diagnoses (ever diagnosed—yes/no), and their self-rated likelihood that they might be diagnosed with either of these conditions in future (5-point Likert—very unlikely to very likely). To explore emotional and psychological responses to the COVID-19 pandemic, participants were provided with a list of options [fearful/anxious, depressed, more connected with people (e.g., via social media or with neighbours/local community), isolated/lonely, hopeful about the future, a reduced sense of control, pessimism about the future, and uncertainty], and asked to select any they had experienced during the COVID-19 pandemic (Have you felt any of the following during the COVID-19 pandemic?).

In July 2020, the second survey was completed by Australian and UK participants of the first survey. The second survey was shorter than the first but revisited many of the items covered in the first survey, including all of those relevant to this analysis. These included any COVID-related changes to living arrangements, work status or conditions, and patterns of alcohol purchasing and consumption. As with the first, the second survey also included the items related to breast cancer and COVID-19 status, and emotional and psychological responses to the ongoing pandemic and its restrictions.

Data Analysis

The current analysis focused on the drivers of alcohol consumption; analyses related to social class and financial status will be the subject of further reports. Specifically, our

TABLE 1 | Characteristics of Australian and UK participants at entry ($N = 2,437$).

Characteristic	Australia	UK	*p-value
Age in years—median (range):	54 (45–64)	53 (45–64)	**0.020**
Completed tertiary education—n (%):	711 (58.4)	635 (52.1)	**0.002**
Children living at home—n (%):	494 (40.6)	540 (44.3)	0.062
**Parenting without partner—n (%):	333 (46.1)	241 (34.1)	**<0.001**
Number—median (range):	2 (1–10)	2 (1–10)	0.896
†Health risk perceptions—n (%)			
Likely to get COVID-19:	104 (8.7)	259 (22.7)	**<0.001**
Likely to develop breast cancer:	82 (9.2)	105 (11.0)	0.197
Usual employment status— n(%)			
Any paid work:	789 (64.8)	910 (74.7)	**<0.001**
Full time work:	409 (33.6)	587 (48.2)	**<0.001**
††Change in work conditions— n (%)			
Required to work from home:	133 (15.9)	239 (26.6)	**<0.001**
Lost a job:	71 (17.5)	90 (15.3)	0.359
Lost hours:	196 (24.8)	154 (16.9)	**<0.001**
Forced to take leave:	55 (7.0)	32 (3.5)	**0.001**
‡AUDIT-C scores—median (range):	3 (1–11)	4 (1–12)	**<0.001**
"Stockpiling" of alcohol at home n (%)	185 (17.9)	339 (30.4)	**<0.001**
Changes in alcohol consumption—n (%)			**0.001**
More likely to drink alone	316 (30.6)	273 (24.4)	
Change in physical environment from usual drinking	298 (28.8)	492 (44.1)	**<0.001**
Consumes more	246 (23.8)	361 (32.3)	
Consumes less	242 (23.4)	278 (24.9)	
Consumption unchanged	547 (52.9)	578 (42.8)	**<0.001**
‡‡Pattern of increased consumption since COVID-19—n (%)			
More frequent but same amount:	140 (56.9)	197 (54.6)	
More frequent and more alcohol:	76 (30.9)	139 (38.5)	
Same frequency but more alcohol:	30 (12.2)	25 (6.9)	**0.030**

*Statistical tests: Mann-Whitney, Chi-square as appropriate (significance <0.05, in bold font).
**Among those with children living at home (N = 1,034).
†Among those not previously diagnosed with either COVID-19 (N = 2,342) or breast cancer (N = 1,846).
††Among those reporting change in work conditions since COVID-19 (N = 994).
‡Alcohol use disorder identification test—consumption, among those reporting alcohol consumption (N = 1,699).
‡‡Among those reporting increased alcohol consumption (N = 607).

main dependent variables were the AUDIT-C, and alcohol stockpiling behaviour ["During the COVID-19 pandemic, have you taken any measures to ensure access to alcohol (e.g., ordered alcohol online, bought more than usual)?"]. Independent variables were: loss of paid work; health risk perceptions (likelihoods of contracting COVID-19 and developing breast cancer); emotional responses to COVID-19 (fear or anxiety, depression, improved social connexion, loneliness, less in control, pessimism, and uncertainty); and subjective self-report of increased alcohol consumption since COVID-19 ("Would you say you have consumed overall more or less alcohol during the COVID-19 pandemic?"—consumed more/consumed less/consumed the same).

Data were analysed using Stata (release 15, Stata Corporation, College Station, TX, United States). Survey sample characteristics were first analysed descriptively and bivariately to assess differences between Australian and UK participants. To assess patterns that might be reflective of bias introduced by participant attrition, a comparison of all responses among those completing only the first or both surveys was undertaken and confirmed no difference in response patterns once all demographic and alcohol consumption patterns were examined. Using alcohol consumption indicators as the dependent variable, bivariate analyses consisted of Chi-square, Mann-Whitney and t-tests as appropriate. Relative risks and risk difference were calculated, and 95% confidence intervals constructed. Collinearity was assessed using Chi-square, Phi statistics and variance inflation factor where appropriate. McNemar's tests were also used to determine differences in proportions of outcome variables between surveys. Finally, multivariate binary logistic regressions were undertaken to determine independent predictors of alcohol behaviour. All data were analysed at the 0.05 significance level.

RESULTS

In the first survey, there were 1,218 Australian and 1,219 UK participants ($N = 2437$). The characteristics of the participants are presented in **Table 1**. Although quotas were used to ensure participants fell into equivalent tertiles of income, there were several differences in other demographic characteristics between cohorts. Notably, Australian participants were more likely to be parenting without a partner and to be tertiary educated. UK participants were more likely to report having been "usually engaged in paid work" (pre-COVID), including in full time work, and were more likely to report having "experienced changes in their work conditions as a result of COVID-19," although these changes were most commonly due to requirements to work at home. Loss of paid work hours was more commonly reported by Australian participants at the time of the first survey. Although perceptions of the long-term risk posed by breast cancer did not differ between cohorts, women in the UK reported significantly higher perceived likelihood of contracting COVID-19.

UK participants scored higher on the AUDIT-C, with a median score of 4 indicating potentially problematic drinking frequency and were more likely to report having increased their alcohol consumption as time since COVID-19 passed relative to Australian participants. Among those reporting increased alcohol consumption, the change mainly involved greater frequency of drinking in both cohorts. Relative to Australians, UK women were also more likely to report "stockpiling" of alcohol at home as a response to the COVID-19 crisis.

The relationships between selected impacts of COVID-19 that were reported in the first survey and problematic drinking (AUDIT-C score ≥ 4 and stockpiling) are presented in **Table 2**. For both cohorts, the strongest associations were between stockpiling alcohol, consuming more alcohol and drinking at problematic levels. Drinking more alcohol during COVID-19 was associated with nearly five times the likelihood of problematic drinking in Australian women and three times the likelihood in UK women. Stockpiling of alcohol was associated with three times the likelihood of problematic consumption in Australian women, with UK women approaching a similar level of risk.

There were variations between cohorts and effects according to the dependent variable analysed. Higher AUDIT-C scores were associated with loss of paid work in Australian participants as was the perception of risk for breast cancer, neither of which were associated with AUDIT-C scores in UK participants. Increased perceived risk for COVID-19 was not associated with problematic drinking in either group, nor were the majority of emotional/psychological responses for which data were collected. Reported feelings of depression was associated with increased risk for problematic drinking in both participant groups. In Australian women only, higher AUDIT-C scores were associated with feeling more socially connected and, conversely, with feeling isolated and lonely.

In both cohorts, strong univariate relationships were found between most of the independent variables and stockpiling of alcohol, with the exception of feeling "more socially connected." UK women who stockpiled were more likely to report stockpiling if they had lost paid work since the beginning of COVID-19 and also more likely to report stronger perceptions of COVID-19 risk. Australian participants who stockpiled were more likely to report susceptibility to breast cancer than those from the UK. In the first survey, participants who stockpiled from both nations were more likely to report feeling fearful or anxious, depressed, lonely and isolated, less in control, pessimistic about the future and uncertain.

Second Survey

A total of 1,377 of the originally surveyed women participated in the second survey; 799 Australian and 578 UK women. Comparison of all demographic data collected in both surveys showed no statistical differences between samples (for both cohorts in both time periods) and therefore supported the recruitment strategy. Across surveys, the median AUDIT-C score remain the same at 4 (IQ range 2–5) for UK women and 3 (IQ range 2–5) for Australian women. Exact McNemar's tests determined that there were no statistically significant differences in the proportions of participants scoring in the problematic drinking range (≥ 4) between surveys in either cohort. Approximately 30% of participant scores decreased and 30% increased (around 40% were scored the same) between the two surveys, with no differences in these proportions between the two cohorts. An additional 8% of both groups reported commencing stockpiling since completing the first survey, whereas 12% reported having stopped stockpiling since completing the first survey. Although the proportion reporting stockpiling did not change between surveys in the UK, an exact McNemar's test suggested there was a significant increase in stockpiling by Australian women ($p = 0.019$).

Women reported 41 new COVID-19 infections occurring since the previous survey; 20 (2.5%) in Australian and 21 (3.9%) in UK participants. Ten of the 20 Australian cases were reported from Victoria, which was experiencing an outbreak during the time of the second survey. The incidence figures were not significantly different despite the larger case numbers and transmission risk in the UK. Perhaps due to this context, women in the UK were significantly more likely to report feeling at risk for COVID-19 than Australian participants (RR = 2.03, 95% CI: 1.54, 2.73, $p < 0.001$) although they were also more likely to report susceptibility for breast cancer (RR= 1.72, 95% CI: 1.23, 2.42, $p = 0.002$). Unlike the first survey, neither perceptions of COVID-19 or breast cancer risk were associated with AUDIT-C score or stockpiling of alcohol in either cohort. A small proportion of women reported increased fear of contracting COVID-19 between surveys ($\sim 6\%$ in both cohorts), but this was also not associated with alcohol consumption or stockpiling. UK women were more likely than Australian women to have lost work between the two surveys (RR= 1.49, 95% CI: 1.34, 1.96, $p = 0.004$) but this was not associated with alcohol consumption (per AUDIT-C) or stockpiling of alcohol.

The reported impacts of COVID-19 identified in the second survey are presented in **Table 3**. In UK women, depression was associated with problematic drinking as were feelings of

TABLE 2 | COVID-19 impacts at entry, problematic drinking, and alcohol stockpiling (N = 2,437).

Reported impact	*AUDIT-C score ≥4—†RR (CI)	Alcohol stockpiling—†RR (CI)
‡Lost paid work since COVID-19		
Australia:	0.96 (0.80, 1.15)	1.26 (0.99, 1.60)
UK:	**1.17 (1.03, 1.32)**	**1.30 (1.03, 1.65)**
§Health risk perceptions		
Likely to contract COVID-19		
Australia:	1.02 (0.80, 1.31)	**1.99 (1.30, 3.03)**
UK:	1.07 (0.95, 1.21)	1.24 (0.99, 1.56)
Likely to develop breast cancer		
Australia:	**1.29 (1.03, 1.61)**	1.44 (0.88, 2.34)
UK:	1.17 (0.99, 1.37)	**1.62 1.10, 2.37)**
Responses to COVID-19		
• Fearful or anxious		
Australia:	1.05 (0.91, 1.21)	**1.96 (1.50, 2.54)**
UK:	1.05 (0.95, 1.16)	**1.47 (1.23, 1.76)**
• Depressed		
Australia:	**1.26 (1.09, 1.47)**	**2.03 (1.57, 2.63)**
UK:	**1.19 (1.07, 1.33)**	**1.58 (1.32, 1.89)**
• More socially connected		
Australia:	**1.18 (1.01, 1.40)**	1.26 (0.92, 1.72)
UK:	0.94 (0.82, 1.06)	1.20 (0.99, 1.47)
• More lonely and isolated		
Australia:	**1.26 (1.09, 1.45)**	**1.80 (1.39, 2.34)**
UK:	0.98 (0.86, 1.11)	**1.28 (1.05, 1.56)**
• Less in control		
Australia:	1.07 (0.92, 1.23)	**1.59 (1.23, 2.07)**
UK:	1.08 (0.98, 1.20)	**1.57 (1.32, 1.88)**
• Pessimistic about the future		
Australia:	1.16 (0.99, 1.36)	**1.86 (1.43, 2.41)**
UK:	1.08 (0.97, 1.20)	**1.67 (1.40, 1.98)**
*AUDIT-C score ≥4		
Australia:	–	**3.81 (2.80, 5.18)**
UK:	–	**3.38 (2.63, 4.35)**
Drinking more alcohol since COVID-19		
Australia:	**4.71 (3.58, 6.21)**	**3.36 (2.79, 4.06)**
UK:	**3.04 (2.53, 3.65)**	**2.79 (2.37, 3.29)**

*Alcohol use disorder identification test—consumption.
†Risk Ratio (95% confidence interval)—p < 0.05 in bold font.
‡Among those reporting having lost any paid work (N = 1,699).
§Among those not previously diagnosed with either COVID-19 (N = 2,342) or breast cancer (N = 1,846).

loneliness and isolation in Australian women. As with survey one, most negative emotional responses to the pandemic were associated more strongly with alcohol stockpiling than AUDIT-C score in both groups. Among women reporting emotional responses for the first time in survey 2, only newly reported depression was associated with problematic drinking in UK women, and with stockpiling of alcohol in both groups. As with the first survey, self-report of an increase in alcohol consumption since COVID-19 was strongly associated with both AUDIT-C score and stockpiling, particularly in Australian women, with more than seven times the risk for stockpiling.

Multivariate Analyses

AUDIT-C scores and alcohol stockpiling were strongly associated with each other; however, the predictors of the outcomes included here were more consistently linked to stockpiling. For this reason, we fit separate multivariate log binomial models to assess independent predictors of alcohol stockpiling in participants of the both surveys (**Table 4**). At the first time point, feeling fearful or anxious, lonely or isolated and uncertainty were no longer significantly associated with alcohol stockpiling once we had adjusted for the other emotional responses to COVID-19, specifically feelings of depression, loss of control,

TABLE 3 | Selected COVID-19 impacts in the second survey, problematic drinking, and alcohol stockpiling (N = 1,377).

Reported impact	*AUDIT-C score ≥4—†RR (CI)	Alcohol stockpiling—†RR (CI)
• Fearful or anxious		
Australia:	1.12 (0.93, 1.35)	1.27 (0.93, 1.74)
UK:	1.09 (0.93, 1.27)	**1.53 (1.14, 2.06)**
• Depressed		
Australia:	1.11 (0.91, 1.37)	**1.72 (1.12, 2.68)**
UK:	**1.32 (1.13, 1.54)**	**1.51 (1.02, 2.24)**
• More lonely and isolated		
Australia:	**1.32 (1.09, 1.59)**	**2.04 (1.43, 2.91)**
UK:	0.98 (0.86, 1.11)	1.07 (0.75, 1.52)
• Less in control		
Australia:	1.10 (0.92, 1.33)	‡**1.59 (1.11, 2.27)**
UK:	1.03 (0.88, 1.21)	**1.41 (1.04, 1.91)**
• Pessimistic about the future		
Australia:	1.15 (0.95, 1.39)	**2.14 (1.50, 3.05)**
UK:	0.91 (0.77, 1.08)	**1.62 (1.20, 2.19)**
• Uncertainty		
Australia:	0.93 (0.77, 1.13)	1.27 (0.86, 1.90)
UK:	1.05 (0.89, 1.23)	**1.58 (1.11, 2.5)**
Started feeling depressed since the first survey:		
Australia:	0.97 (0.73, 1.30)	**1.72 (1.12, 2.68)**
UK:	**1.39 (0.17, 1.66)**	**1.51 (1.02, 2.24)**
Drinking more alcohol since COVID-19		
Australia:	**2.33 (2.00, 2.74)**	**7.16 (4.97, 10.33)**
UK:	**1.58 (1.37, 1.82)**	**2.72 (2.02, 3.65)**

*Alcohol use disorder identification test—consumption.
†Risk ratio (95% confidence interval)—p < 0.05 in bold font.
‡No longer significant once Victoria (in which the residents were experiencing a second lockdown) was excluded.

TABLE 4 | *Independent predictors of alcohol stockpiling in midlife women in Australia and the United Kingdom—May and July 2020.

Model 1—survey 1 (n = 2152)	Relative Risk (95% CI)	Risk Difference (95% CI)	p-value
Depressed	1.39 (1.19, 1.62)	0.10 (0.06, 0.15)	<0.001
Less in control	1.33 (1.14, 1.55)	0.06 (0.02, 0.10)	<0.001
Pessimistic about the future	1.43 (1.23, 1.67)	0.10 (0.05, 0.14)	<0.001
Tertiary educated	0.82 (0.71, 0.95)	−0.05 (−0.08, −0.01)	0.008
Resident of United Kingdom	1.58 (1.35, 1.83)	0.10 (0.07, 0.13)	<0.001
Model 2—survey 2 (n = 1222)	**Relative Risk (95% CI)**	**Risk Difference (95% CI)**	**p-value**
Fearful or anxious	1.49 (1.17, 1.89)	0.07 (0.03, 0.11)	0.001
Pessimistic about the future	1.64 (1.29, 2.07)	0.10 (0.05, 0.16)	<0.001
Tertiary educated	0.71 (0.56, 0.89)	−0.07 (−0.11, −0.02)	0.003
Resident of United Kingdom	1.53 (1.21, 1.93)	0.08 (0.03, 0.12)	<0.001

*Both models are adjusted for age.

and pessimism about the future. Being below the median age of 54 years and being a resident of the UK also independently predicted alcohol stockpiling. Tertiary education, regardless of country, was protective against stockpiling behaviour.

In the second model (**Table 4**), once we adjusted for the other emotional responses to COVID-19, feeling less control, depressed, lonely or isolated, and uncertain did not retain

significance in the multivariate binary regression. By survey two, stockpiling was independently predicted by feeling fearful or anxious and feeling pessimistic about the future. As with the first time point, being a UK resident also predicted alcohol stockpiling and tertiary education was protective against this behaviour.

We regressed changes in emotional responses for all variables between surveys, but only changes in depression status

TABLE 5 | *Independent predictors of alcohol stockpiling at survey 2 in midlife women in Australia and the United Kingdom—May–July 2020 (n = 1,222).

Predictors	Relative risk (95% CI)	Risk difference (95% CI)	*p*-value
Started feeling depressed between surveys	1.53 (1.14, 2.04)	0.10 (0.03, 0.18)	0.004
Pessimistic at survey 1	1.42 (1.11, 1.81)	0.08 (0.03, 0.13)	0.005
Fearful or anxious at survey 1	1.33 (1.05, 1.70)	0.05 (0.01, 0.09)	0.020
Tertiary educated	0.69 (0.54, 0.87)	−0.06 (−0.12, −0.02)	0.002
Resident of United Kingdom	1.51 (1.20, 1.91)	0.08 (0.04, 0.12)	<0.001

Model is adjusted for age.

significantly predicted alcohol stockpiling by survey two. The age-adjusted RR for newly reported depression was 1.59 (95% CI: 1.18, 2.14, $p = 0.002$), but further modelling indicated that none of the reported changes in emotional status between surveys predicted AUDIT-C score at the second time point. Our final model investigating independent predictors across both time points for the outcome of alcohol stockpiling at the second time point is presented in **Table 5**. Reporting depression for the first time between surveys was strongest predictor of stockpiling in the second survey, followed by reporting pessimism and fearfulness/anxiety in the first survey. Residence in the UK predicted stockpiling at time point two and tertiary education continued to be protective in this model.

DISCUSSION

This study investigated the impact of COVID-19 on midlife women's alcohol consumption and perceptions of health risk in two Westernised countries with a similar sociality and culture with respect to patterns of alcohol consumption (27, 28). Our findings indicate that COVID-19 lead to more risky practises with respect to alcohol and that this was predicted by negative emotional responses to the pandemic.

The numbers of cases and rates of community transmission were very much higher in the UK relative to Australia at the time of both surveys (31, 38). It is therefore not surprising that UK participants reported heightened perceptions of personal risk with regard to COVID-19 infection. In contrast, the longer-term potential risk posed by breast cancer was similar between cohorts, notwithstanding the cancer risk associated with the more frequent alcohol consumption reported by UK women. Neither perceptions of short- or long-term health risks predicted greater alcohol consumption in either group on multivariate analyses. The impact of the lockdown itself may have been more influential than the fear of the short-term risk of contracting COVID-19, with longer term risk for breast cancer also not uppermost in mind. As discussed by Bavli et al. (39), lockdowns have been useful for limiting transmission of COVID-19, but inevitably come with a fair degree of "collateral damage" such as harms associated with delays in health investigations and treatment. As previously noted, this includes reductions in preventive care for health conditions such as breast cancer (12).

Recent data from other studies indicate that women in both countries are more likely to report increased alcohol

consumption than reduced consumption since COVID-19 (25, 26). Our results extend this to indicate that residence in the UK independently predicted alcohol stockpiling, which was closely associated with alcohol consumption in our study. This relationship persisted at each time point and across the study period even after controlling for the protective effect of tertiary education, which a smaller proportion of UK respondents had completed. In discussing increased convergence in drinking between men and women in the UK, Nicholls (40) discusses the demise of the working man's pub and the rise of the "night time economy," where all forms of alcohol consumption (pre-drinking and in pubs and clubs) comes to play an important role in "doing" gender (whether pre-drinking with friends, and in bars, pubs and clubs). Further investigation might uncover whether this may help to explain the persistence of greater alcohol consumption in UK women during lock down, where alcohol would be consumed less publicly.

Although stockpiling alcohol and problematic drinking were strongly correlated in both cohorts, the individual drivers of these behaviours were not necessarily the same. Assuming that stockpiling is an indication of "intention" to consume alcohol in the future, emotional responses to the pandemic (including depression, fear and anxiety, and pessimism) were strongly associated individually with alcohol stockpiling, but these same emotions were not necessarily associated with consumption at problematic levels, as indicated by the AUDIT-C.

The *intention* to act in the future is indicated through the purchasing of specific items, with stockpiling suggesting purchase that exceeds current use, and fear of scarcity regarding future availability of alcohol. The phenomenon of stockpiling has been reported in other research into infectious disease outbreaks (41). Moreover, the stockpiling of other items including guns, toilet paper and gold, has also been associated with higher levels of COVID-related anxiety (42). This potentially indicates that the stockpiling behaviour could be a preparation for a worsening of the pandemic and that alcohol offered the participants a chance to prepare for a worsening of the situation driven by their feelings of depression, fear and anxiety and pessimism. While this would require further research, across our study period, pessimism was a key emotional response predicting stockpiling at both time points. Our findings suggest that pessimism and anxiety at the first time point may have gradually given rise to depression. It is possible that the tedium of the pandemic and associated lockdowns ultimately "wore people down" overtime while underscoring their need to prepare for the "long haul."

As is argued by Ogden (43), people under stress may experience a distortion of time, with reduced socialisation associated with an apparent slowing of the passage of time. Robb et al. (44) found that women in the UK reported worsening depression and anxiety symptoms after lockdown, which were more severe than those reported by men. It is noteworthy that 12% of our participants reported feeling depressed and 29% reported feeling anxious or fearful at both time points. Whether these are responsive to the circumstances or represent pre-existing mental health conditions, such feelings persisting throughout the intervening period may predict persisting psychological morbidity related to the lockdown (45).

Regardless of measurable changes in AUDIT-C scores, participant perceptions of increased drinking were strongly linked to both stockpiling and problematic drinking and this was particularly evident in the Australian sample. Although a greater proportion of UK women reported that they were consuming more alcohol, the impact of COVID-19 on AUDIT-C and stockpiling was greater for Australian women with previously problematic drinking. Some of this may be due to increased availability of alcohol in Australia, even during lockdown. In recent years, the density of alcohol outlets (offering on- and off premises consumption) in Australia has increased without reference to the number of other outlets whilst the UK has been limiting alcohol licences on the basis of the local density of other alcohol selling premises (46). Although an alcoholic drink was reported to be <18 min away in both countries pre-COVID (among the shortest times in the world), bulk shopping was available from large alcohol-specific warehouses only in Australia (47). On premises alcohol consumption was not possible during lockdown, but businesses specialising in alcohol sales were considered "essential services" in both countries, with home delivery services also only available in Australia before and during COVID-19 (48, 49). Substance use issues in vulnerable populations have been noted to worsen as a direct impact of social-distancing measures (39), the significance of which is heightened by reduced access to support services that might normally be available for alcohol issues due to the lockdown (50).

Tertiary education was protective for both problematic alcohol consumption and alcohol stockpiling in both cohorts and across time. It has long been noted that education is strongly linked with improvements in nearly all health and mortality outcomes, which is thought to be attributable to higher incomes, better nutrition, less crowded housing, and increased access to health care services (51, 52). While the relationship between environmental circumstances and alcohol consumption remains equivocal, Lui et al. (53) found that education and alcohol consumption were positively correlated with each other, stating (page 4) that a "…positive SES gradient was found such that with each level of higher education, more alcohol was consumed in the past year for both genders." More consistent with our results, however, Lui et al. (53) also found that problematic drinking such as "heavy episodic drinking" was inversely related to education level in mid-aged people (53).

We used quota sampling to recruit midlife women with similar distributions of household income, however the two populations differed significantly on most other demographic variables. Prior to COVID-19, UK women were reported to drink more alcohol per capita than Australian women (17), which aligned with our findings. Despite these differences, the emotional responses to COVID-19 that independently predicted stockpiling behaviour were strikingly similar. Globally, increased prevalences of depression and anxiety in association with COVID-19 related lockdowns have been identified (11, 39). Despite the clear increased need, the lockdowns have affected access to mental, many of which have closed with acute health services prioritising treating COVID-19 cases, particularly in countries with high infection rates (54). This situation has led to warnings that mental health could be the "next pandemic" (55), which our findings suggest could be swiftly followed by a pandemic of alcohol-related harms.

Limitations

We used quota sampling on tertiles of income and restricted the survey to healthy women aged 45–64 years, however there were many other differences between the two cohorts. Although many of the differences of which we are aware are unlikely to have directly impacted on alcohol consumption behaviour, there are potentially a range of socio-cultural, commercial and policy related factors (for which we did not collect data) that are likely to have had direct impacts on behaviour. Our multivariate analyses informed our conclusion that "country of residence" was an independent risk factor for alcohol stockpiling, but future investigation is required to unpack the relative influence of some of the commercial and structural components of this relationship.

Perhaps unsurprisingly, we were not able to collect baseline (pre-COVID) data with which to compare changes at each time point. Although self-reported information on changes in behaviour since before COVID-19 was collected, it is important to acknowledge that our findings are most relevant to the period between the two survey points. Although the Oxford Stringency Index was similar for each country at both periods, there was substantial local variability within nations. For example, the second survey was administered at a time when a second lockdown was occurring in one jurisdiction of Australia, representing 28% of our Australian cohort at that time point. Separate analyses excluding the Victorian participants did not demonstrate any differences to our findings, however it is not possible to rule out potential influence of other variability in local and national contexts.

The survey included the well-validated AUDIT-C instrument (36, 37) to collect information about the volume and frequency of alcohol consumption and asked for subjective self-reports of increased alcohol consumption since COVID-19. As is common to many surveys, our reliance on self-reports may have led to an under-estimation of alcohol consumption. The complete anonymity of the online survey and strong likelihood that participants would completed it in private, however, may have reduced the likelihood of socially desirable responding.

Finally, subjective emotional responses to the pandemic were collected in the survey and the analyses focused on the reported feelings of depression and anxiety and fearfulness. Measuring depression and anxiety using validated psychological instruments in this survey was beyond the scope of this study, associations

found between these reported feelings and alcohol behaviours should be interpreted cautiously. Nonetheless, our findings do implicate between negative emotional affect in alcohol practises and strongly suggest this as an area for future investigation.

CONCLUSIONS

In this study, COVID-19 was associated with increases in risky alcohol practises, specifically alcohol stockpiling and problematic drinking, and this was predicted by negative emotional responses to the pandemic. Our findings suggest that pessimism and anxiety that were evident at the first time point may have gradually given rise to depression, which if persisting over time may predict more entrenched psychological morbidity. COVID-19 was associated with greater risk with respect to alcohol consumption among the already vulnerable subgroups in Australia. It is important that access to mental health support services during lockdown and beyond is enhanced. Future public health research could include how the local and national context of alcohol consumption and the actions of commercial players interact with individual decisions to stockpile as well as confirming and investigating why tertiary education seems to be protective against stockpiling.

Anxiety, pessimism and depression were emotional responses to COVID-19 that predicted stockpiling behaviour in UK and Australian women despite the many demographic and contextual differences between these two cohorts. Increasing prevalence of depression and anxiety in association with COVID-19 related lockdowns has been noted around the world, and there is growing evidence that the mental health issues developed or exacerbated during lockdown may continue long after lockdown is lifted. If mental health harms become the "next pandemic," our findings suggest that this could be swiftly followed by a pandemic of alcohol-related harms.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors on reasonable request, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Flinders University Human Research Ethics Committee. Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

AUTHOR CONTRIBUTIONS

EM contributed to the design and implementation of the study, analysed the data, and drafted the manuscript. IO, CW, BL, SM, KF, JT, and PW contributed to the study design and drafting of the manuscript. BT contributed statistical expertise to the analysis and drafting of the manuscript. All authors reviewed the manuscript prior to submission.

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Impact of COVID-19 Related Lockdown on the Frequency of Acute and Oncological Surgeries—Lessons Learned From an Austrian University Hospital

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Innsbruck Medical University Hospital, Austria, provides the highest level of care for a region of approximately 1.8 million people. During the early COVID-19 outbreak in spring 2020 surgical activity was drastically reduced with the prime goal of preserving hospital capacities, especially intensive care beds. We conducted a retrospective analysis of surgical activities performed at Innsbruck Medical University Hospital during the lockdown period from March 15 to April 14, 2020 and compared these activities to the same period during the previous 5 years. Total surgical activity was reduced by 65.4% compared to the same period during the previous 5 years ($p < 0.001$); elective surgeries were reduced by 88.7%, acute surgeries by 35.3% and oncological surgeries by 47.8% compared to the previous 5 years (all $p < 0.001$). This dramatic decrease in acute and oncological surgeries can most likely be ascribed to the fact that many patients avoided health care facilities because of the strict *stay-at-home* policy and/or the fear of contracting SARS-CoV-2 in the hospital. In view of future waves, the population should be encouraged to seek medical help for acute symptoms and to attend cancer screening programs.

Keywords: COVID-19, elective surgery, non-elective surgery, acute surgery, public health

INTRODUCTION

Innsbruck Medical University Hospital is the largest hospital in western Austria and provides the highest level of medical care for approximately 1.8 million people. Due to the dramatic increase in SARS-CoV-2 infections in mid-March 2020, especially in popular ski resorts in Tyrol, the authorities ordered a complete *shutdown* of daily life with public health measures such as social distancing, self-isolation and quarantine for the whole region. In accordance with these restrictions, all elective surgical procedures at Innsbruck Medical University Hospital were halted to reduce the risk of infection, harm and death from COVID-19 and to reserve personnel resources and medical equipment for the treatment of critically ill COVID-19 patients (1–3). Exceptions were only envisaged solely for acute and oncological surgery (2).

The question that inevitably arises is how these COVID-19 related restrictions affected our ability to maintain the highest quality care for all our patients, not only SARS-CoV-2-positive patients, as a large number of surgeries were cancelled or postponed that would otherwise have been treated within a tight timeframe. The aim of this retrospective analysis was to determine the effects of the lockdown period from March 15 to April 14, 2020 on the performance of surgical procedures at Innsbruck Medical University Hospital and to compare the numbers with those of the same observation period during the previous 5 years. In view of future lockdowns, our results could serve as a decision guidance for health care authorities striving to establish a safe hospital environment, where not only COVID-19 patients are assured the best possible treatment, but where all other health issues are also attended to in a timely manner.

MATERIALS AND METHODS

Data Collection and Statistical Analysis

After receiving ethics approval (EK Nr: 1124/2020, dated 2020_05_17) from the local Ethics Committee, data on all surgical interventions performed from March 15 to April 14 in the years 2015 to 2020 ($n = 21.481$) were extracted from the surgical planning software myMedis (Getinge, IT Solutions GmbH, Sweden). In a second step all surgical interventions were classified according to the organizational unit, date and time of surgery (core time: 7 a.m.−5 p.m., shift time: 5 p.m.−7 a.m.; weekday versus weekend); in a second step all surgical interventions were manually classified as elective, acute or oncology-related interventions by two medical doctors. The following interventions were classified as oncology-related surgeries: invasive diagnostics requiring anesthesia, major- and minor primary oncological surgery and follow-up procedures. Additionally, all patients were classified according to age, gender and American Society of Anaesthesiologists (ASA) physical status classification system.

Statistical analyses were conducted using R, version 3.5.1. All statistical assessments were two-sided and a significance level of 5% was used. We present the absolute number of surgeries with a 95% CI (confidence interval) for the period 2015 to 2019, other categorical variables as frequencies (%) and continuous data as mean (95% CI). We applied the Exact Poisson test to assess the difference in the number of surgeries between 2015–2019 and 2020, Fisher's exact test for binary variables and the Welch two sample t-test for continuous variables. We show effect size with estimated median differences for continuous data and odds ratios (OR) for binary variables, with 95% CIs.

RESULTS

Patient Demographics, Comorbidities, and Country of Origin

Age distribution of surgical patients was similar during the compared periods, whereas female gender was significantly more frequent in 2020 (54.3 vs. 51.2%; $p = 0.0305$; **Table 1**). Additionally, during the 2020 lockdown period significantly fewer surgical patients were categorized as ASA 1 (21.7 vs. 31.6%;

$p < 0.0001$; **Table 1**), whereas significantly more patients were categorized as ASA 3 and ASA 4 (ASA 3: 34.4 vs. 24.1%; $p < 0.0001$; ASA 4: 5.3 vs. 2.7%; $p < 0.0001$; **Table 1**).

During the 2020 lockdown period patients undergoing surgery were more frequently inhabitants of Tyrol than in previous years (94.2 vs. 89.7%; $p < 0.0001$; **Table 1**).

Numbers of Surgical Interventions

Surgical activities at 13 surgical departments were analyzed (**Table 2**). Between March 15 and April 14, 2020 1.391 surgical interventions were performed at Innsbruck Medical University Hospital, which is a decrease of 65.4% as compared to the mean number of surgeries performed during the same time frame in the previous 5 years (2015–2019; mean = 4.018; $p < 0.0001$; **Table 2**). Of these interventions, 244 were elective (−88.7%; $p < 0.0001$), 903 acute (−35.3%; $p < 0.0001$) and 241 oncological interventions (−47.8%; $p < 0.0001$). The largest reduction in surgical activity was seen at the Department of Orthopaedic Surgery (−84.5%; **Table 2**); the smallest reduction at the Department of Gynaecology and Obstetrics (−28.9%; **Table 2**).

Timing of Performed Surgical Procedures

In the 2020 lockdown phase, 1.105 surgical interventions were performed during core time (7 a.m.−5 p.m.), which is a reduction of 69% as compared to the previous 5 years ($p < 0.0001$). Surgical interventions performed during night shift hours were reduced by 36.4% ($p < 0.0001$). Analysis of the weekends (Saturday and Sunday) showed, that surgical activities across all departments were significantly reduced during the 2020 lockdown as compared to the previous 5 years (−28.4%; $p < 0.0001$; **Figure 1**).

Oncological Surgery

During the observed period in 2020 241 oncological surgeries were performed. Compared to the mean of the previous 5 years, this corresponds to a reduction of 47.8% ($p < 0.0001$).

Detailed analysis of each single oncological entity, however, revealed that numbers of major surgeries for breast, thyroid, hepatic, bladder and testicular cancers were not significantly reduced during the 2020 lockdown period as compared to the previous 5 years. In contrast, a significant reduction in major oncological surgeries was seen for colorectal, pancreatic, gastric, renal, prostatic and brain tumors. Lung cancer surgery was significantly increased during the 2020 lockdown period (**Figure 2**).

DISCUSSION

Our data from the 13 surgical departments at Innsbruck Medical University Hospital show that elective surgical interventions were reduced by 88.7% during the lockdown period in 2020 as compared to the same time frame during the previous 5 years. Most interestingly, also acute and oncological

TABLE 1 | Presented are age, gender, comorbidities, and country of origin of patients during the observation period in 2020 compared to the same period in 2015-19.

	Mean for 2015-2019 with 95% CI[a] (n = 20,090)	2020 (n = 1,391)	Estimate with 95% CI[b]	Decrease (%)[c]	p-value[d]	Missing
Age (years)	54.4 (54.1 to 54.8)	54.8	−0.3 (−1.5 to 0.8)	−0.6 (−1.2 to 0)	0.5816	0/0
Gender (female)	51.2% (50.2% to 52.3%)	54.3%	1.1 (1 to 1.3)	−5.9 (−8.2 to −3.8)	0.0305	0/0
Country of origin (Tyrol)	89.7% (88.6% to 90.7%)	94.2%	1.9 (1.5 to 2.4)	−5.1 (−6.3 to −3.9)	<0.0001	0/0
ASA Score = 1	31.6% (28.3% to 34.9%)	21.7%	0.6 (0.5 to 0.7)	31.3 (23.3 to 37.8)	<0.0001	345/6736
ASA Score = 2	41.5% (38.2% to 44.8%)	38%	0.9 (0.8 to 1)	8.5 (0.7 to 15.2)	0.0224	345/6736
ASA Score = 3	24.1% (23.6% to 24.5%)	34.4%	1.7 (1.4 to 1.9)	−43 (−45.6 to −40.5)	<0.0001	345/6736
ASA Score = 4	2.7% (2.2% to 3.1%)	5.3%	2 (1.5 to 2.7)	−98.2 (−138.6 to −69.5)	<0.0001	345/6736
ASA Score = 5	0.2% (0.1% to 0.3%)	0.6%	3.2 (1.1 to 8.1)	−224.7 (−815.7 to −97.4)	0.0191	345/6736

ASA refers to the American Society of Anaesthesiologists physical status classification system.
[a]Assessed by t-test.
[b]Odds ratios assessed by Fisher's Exact Test for binary variables and estimated mean difference assessed by Welch two sample t-test for continuous variables.
[c]Calculated as 100/(mean 2015-2019)(mean 2015-2019-2020).*
[d]Assessed by Fisher's Exact Test for categorical variables and Welch two sample t-test for continuous variables.

TABLE 2 | Presented are the total number of surgical procedures and the procedures in each surgical subspecialty during the observation period in 2020 compared to the same period in 2015-19.

	Mean 2015-2019 with 95% CI[a]	2020	Estimate with 95% CI[b]	Decrease (%)[c]	p-value[a]
Total number of surgeries	4018 (3962.6 to 4074)	1391	2627 (2571.6 to 2683)	65.4 (64.9 to 65.9)	<0.0001
Elective surgeries	2153.8 (2113.3 to 2194.9)	244	1909.8 (1869.3 to 1950.9)	88.7 (88.5 to 88.9)	<0.0001
Acute surgeries	1395.6 (1363 to 1428.7)	903	492.6 (460 to 525.7)	35.3 (33.8 to 36.8)	<0.0001
Oncological surgeries	461.6 (443 to 480.8)	241	220.6 (202 to 239.8)	47.8 (45.6 to 49.9)	<0.0001
Surgical subspecialities					
Ophthalmology	880.4 (854.6 to 906.8)	153	727.4 (701.6 to 753.8)	82.6 (82.1 to 83.1)	<0.0001
Vascular surgery	174.6 (163.2 to 186.6)	118	56.6 (45.2 to 68.6)	32.4 (27.7 to 36.8)	<0.0001
Cardiac surgery	164.4 (153.4 to 176)	96	68.4 (57.4 to 80)	41.6 (37.4 to 45.5)	<0.0001
Paediatric surgery	55.6 (49.3 to 62.5)	13	42.6 (36.3 to 49.5)	76.6 (73.6 to 79.2)	<0.0001
Gynaecology and obstetrics	459.8 (441.2 to 479)	327	132.8 (114.2 to 152)	28.9 (25.9 to 31.7)	<0.0001
Ear, nose and throat surgery	210.6 (198.1 to 223.7)	42	168.6 (156.1 to 181.7)	80.1 (78.8 to 81.2)	<0.0001
Cranio, maxillofacial and oral surgery	296 (281.1 to 311.5)	52	244 (229.1 to 259.5)	82.4 (81.5 to 83.3)	<0.0001
Neurosurgery	236.2 (222.9 to 250.1)	78	158.2 (144.9 to 172.1)	67 (65 to 68.8)	<0.0001
Orthopaedic surgery	233 (219.8 to 246.8)	36	197 (183.8 to 210.8)	84.5 (83.6 to 85.4)	<0.0001
Plastic surgery	272.6 (258.3 to 287.5)	83	189.6 (175.3 to 204.5)	69.6 (67.9 to 71.1)	<0.0001
Trauma surgery	376.6 (359.8 to 394)	122	254.6 (237.8 to 272)	67.6 (66.1 to 69)	<0.0001
Urology	290.4 (275.7 to 305.7)	87	203.4 (188.7 to 218.7)	70 (68.4 to 71.5)	<0.0001
Visceral, transplant and thoracic surgery	367.8 (351.2 to 385)	184	183.8 (167.2 to 201)	50 (47.6 to 52.2)	<0.0001

[a]Assessed by Poisson Test.
[b]Estimated mean difference assessed by Poisson Test.
[c]Calculated as 100/(mean 2015-2019)(mean 2015-2019-2020).*

surgeries were significantly reduced. Patients were generally sicker as evidenced by significantly higher ASA scores. The reduction in surgical interventions applied to all surgical disciplines and was more pronounced on weekdays than on weekends.

The reduction in trauma-associated acute surgeries (decrease of 67.6%; $p < 0.0001$) is most likely due to quarantine regulations in force at the time, which essentially prohibited all accident-prone outdoor activities such as skiing, mountaineering and paragliding. Additionally, with the closing of the Austrian

border on March 15, about 150,000 tourists left the country, thereby significantly reducing the number of potential patients. Unexpected and therefore more difficult to explain, however, was the decline in acute interventions in other surgical disciplines, such as acute vascular occlusion in vascular surgery, acute appendicitis in general surgery or abscess incisions in oral and maxillofacial surgery. One possible explanation for the steep decline in acute interventions could be the so-called "COVID-19 collateral damage syndrome" (4). Many different medical specialists (surgeons, emergency physicians,
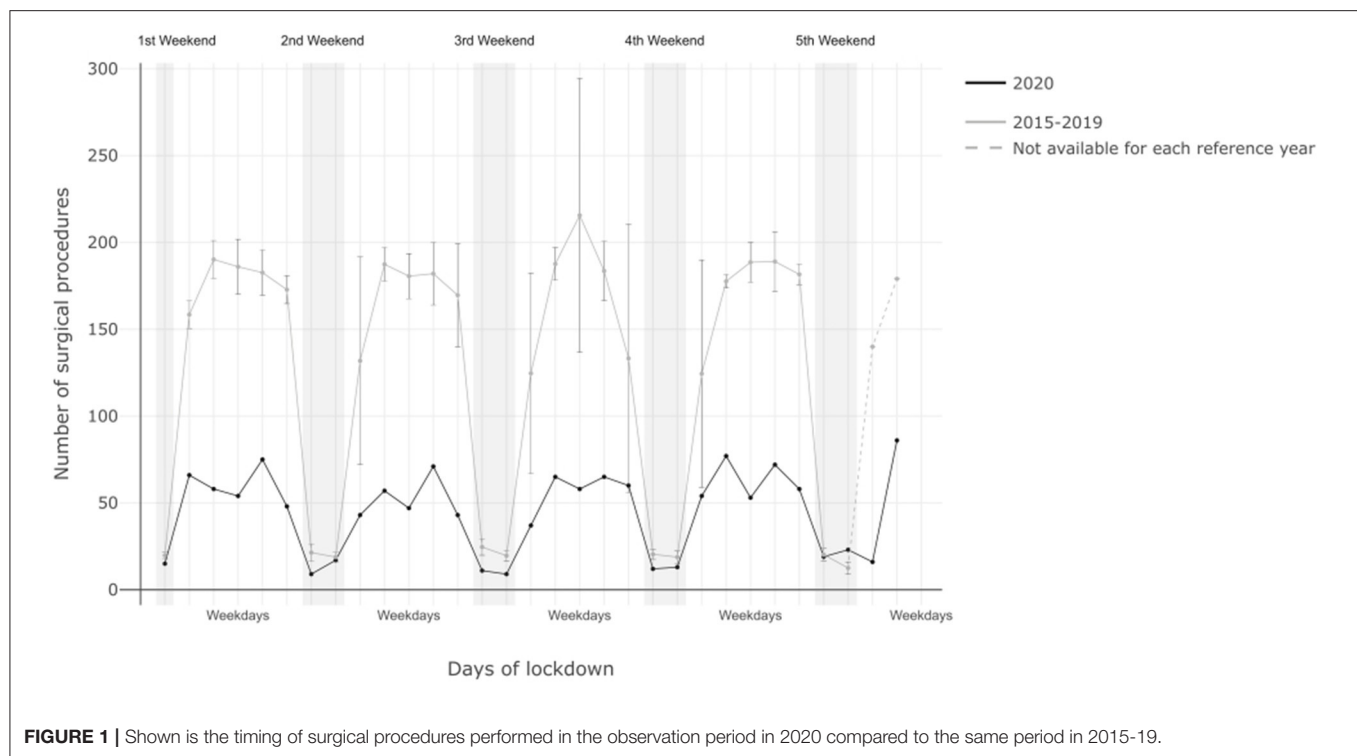
FIGURE 1 | Shown is the timing of surgical procedures performed in the observation period in 2020 compared to the same period in 2015-19.

cardiologists and neurologists) report that the number of acute patients has decreased during the pandemic (5–7) and that acute conditions led to more complications due to delayed presentation (8). The decline in emergency surgeries is comparable to observations reported from other countries, where a reduction of approximately 30% in acute surgical activity was described (9). One possible explanation for this uniform finding could be that lockdown measures such as the rigorous *stay-at-home* directive may have discouraged symptomatic patients from seeking early emergency treatment for non-COVID-19-related medical conditions; second, it can be hypothesized that also the fear of contracting COVID-19 in a health care facility may have further decreased the number of patients seeking medical help. This aspect is notable, especially in view of the potential collateral health damage that can occur, if certain medical conditions are not treated within a short timeframe (4). At Innsbruck Medical University Hospital the decrease in acute interventions can probably be explained by fewer patients coming to emergency departments, as there was never a shortage of staff, medical equipment or intensive care capacity. It may also be possible that the pandemic helped to accelerate implementations of recent findings into clinical practice, such as a more conservative, antibiotic based approach in case of simple uncomplicated appendicitis, which has been shown to be a safe alternative to surgery (10–12). Another important finding is that also oncological surgery was significantly reduced during the lockdown period. This is in fact surprising as scheduled or even short-dated oncologic procedures were not cancelled or postponed. This may be attributable to a COVID-19-related reduction in allocation from

primary health care centers and to the fact that diagnostic procedures also significantly declined during this period. In addition, a decline in incidental findings and in positive results from cancer screening programs may have probably led to a reduction in oncological surgeries. This finding is alarming, as even modest delays in cancer surgery have a significant impact on survival (13).

Austrian mortality data show that between March 1 and April 30, 2020 overall mortality increased by 1%, peaking in mid-April, when mortality was 16% higher than in the same time period during the previous 5 years (14). However, only 3.9% of all deaths during these 2 months were causally related to COVID-19 infection, whereas death rates from cerebrovascular causes, from myocardial infarction and from lung cancer were still higher. Cerebrovascular diseases and cancer remain the leading causes of death. During the current pandemic it is therefore of paramount importance to strengthen the public's awareness for cerebrovascular diseases and its risk factors as well as the importance of attending cancer screening programs.

CONCLUSIONS

In summary, our data show that during the lockdown period from March 15 to April 14, 2020 acute and oncology patients were less likely to undergo surgical interventions by comparison to the same period in the previous 5 years. These findings emphasize once again a major challenge of the current pandemic, namely the difficult provision of access to health care facilities
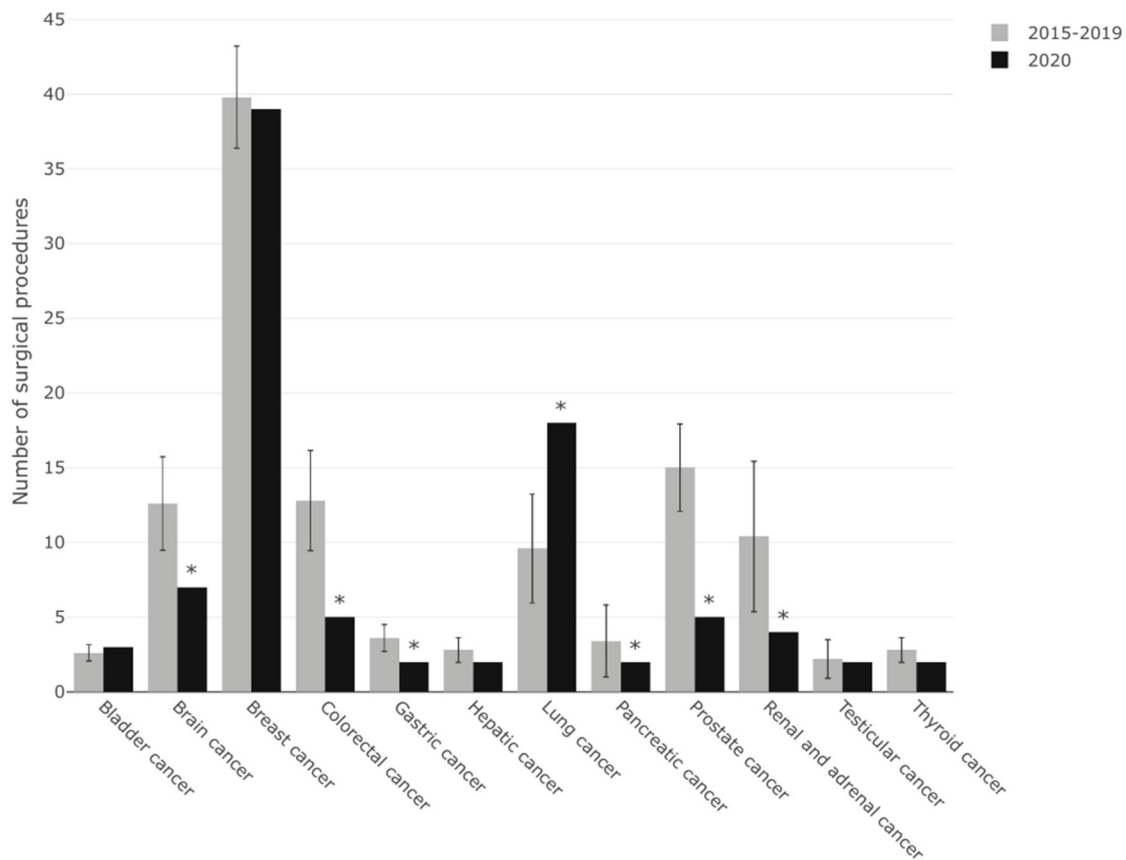
FIGURE 2 | Shown is the number of oncologic surgeries for major oncologic entities performed during the 2020 observation period compared with the same period in 2015-19.

and medical services to the entire population, not only persons infected with SARS-CoV-2. On the one hand, this implies efforts to keep medical systems running, including cancer screening programs and diagnostic procedures; on the other hand, massive efforts should be undertaken in healthcare facilities to reassure patients that every possible precaution is being taken to prevent viral transmission, including rigorous and repeated testing of all healthcare workers and all admitted patients. In fact, since the end of May 2020 all surgical patients at the Innsbruck Medical University Hospital have been screened for SARS-CoV2 and since December 2020 all health care workers are obligated for weekly testing. It is of prime importance to create a healthcare environment where patients feel safe and are not afraid to seek medical help. If this is not ensured, the collateral damage from non-COVID-19-related health issues will cause enormous social and economic consequences for the entire healthcare system.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The study was approved by the Ethics Committee of the Medical University of Innsbruck, Austria.

AUTHOR CONTRIBUTIONS

LG, GP, and JM: conceptualization, methodology, validation, writing the original draft preparation, supervision, and project administration. JA, LG, GP, and JM: formal analysis. JA and TH: data curation. JA, LG, GP, PS, SM, TH, and JM: writing the review and editing. TH: visualization. All authors contributed to the article and approved the submitted version.

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Early Surveillance and Public Health Emergency Responses Between Novel Coronavirus Disease 2019 and Avian Influenza in China: A Case-Comparison Study

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Background: Since the novel coronavirus disease (COVID-19) has been a worldwide pandemic, the early surveillance and public health emergency disposal are considered crucial to curb this emerging infectious disease. However, studies of COVID-19 on this topic in China are relatively few.

Methods: A case-comparison study was conducted using a set of six key time nodes to form a reference framework for evaluating early surveillance and public health emergency disposal between H7N9 avian influenza (2013) in Shanghai and COVID-19 in Wuhan, China.

Findings: A report to the local Center for Disease Control and Prevention, China, for the first hospitalized patient was sent after 6 and 20 days for H7N9 avian influenza and COVID-19, respectively. In contrast, the pathogen was identified faster in the case of COVID-19 than in the case of H7N9 avian influenza (12 vs. 31 days). The government response to COVID-19 was 10 days later than that to avian influenza. The entire process of early surveillance and public health emergency disposal lasted 5 days longer in COVID-19 than in H7N9 avian influenza (46 vs. 41 days).

Conclusions: The identification of the unknown pathogen improved in China between the outbreaks of avian influenza and COVID-19. The longer emergency disposal period in the case of COVID-19 could be attributed to the government's slower response to the epidemic. Improving public health emergency management could lessen the adverse social effects of emerging infectious diseases and public health crisis in the future.

Keywords: COVID-19, emerging infectious diseases, H7N9, emergency management, China

INTRODUCTION

In the past 20 years, China has experienced several public health crises due to infectious disease outbreaks, such as severe acute respiratory syndrome in 2003, H1N1 swine influenza in 2009, and H7N9 avian influenza in 2013, seriously impacting health, economy, and global security (1–3). These outbreaks challenged the health emergency management in several countries, especially

developing countries, including China (4, 5). In late December 2019, the novel coronavirus disease 2019 (COVID-19) emerged in Wuhan City, China, and rapidly spread worldwide (6). Prior to March 5, 2020, the Chinese government reported 80,409 confirmed cases and 3,012 fatalities due to COVID-19 (7).

COVID-19 and H7N9 avian influenza are two emerging infectious diseases that share similar characteristics (**Table 1**), such as probable development of severe respiratory diseases and susceptibility regardless of age. However, the socioeconomic losses were higher in COVID-19 outbreak than in H7N9 avian influenza. An effective public health emergency management reduces the adverse impact of emerging infectious diseases (8). This management relies on the early surveillance and timely information dissemination available in a given period (9). The following three key responses are often analyzed to evaluate the efficiency of public health emergency disposal: (1) time taken by the hospital to report an emerging infectious disease, (2) time taken to identify the pathogen, and (3) time taken by the government to respond (10–12). The World Health Organization declared a Public Health Emergency of International Concern on January 30, 2020 (13). Since then, China established and strengthened the national and local surveillance systems as well as emergency responses to prevent and control the spread of COVID-19 (14). Comparing the infectious disease surveillance and public health emergency disposal between different outbreaks in China could assist in improved public health strategies and decision-making by the government to prevent and control epidemics in the future, both in China and the world. To the best of our knowledge, few studies have been conducted to investigate the early disease surveillance and public health emergency disposal between other epidemics and COVID-19 in China.

In this study, we aimed to conduct a retrospective study to compare the COVID-19 in Wuhan with the well-controlled H7N9 avian influenza (2013) in Shanghai, China, which should include the contents of the detection of the case, the initiation of emergency response, and etc. With the detailed comparison, the study would be able to summarize the lessons and propose measures to better improve the immediate responses to emergent public health events.

METHODS

Data Collection

Data regarding the public health emergency disposal of the novel COVID-19 in Wuhan City, China, were obtained from published literature, secondary statistical data, WHO reports (3), official websites [e.g., National Health Commission of the People's Republic of China (http://en.nhc.gov.cn/), Chinese Center for Disease Control and Prevention (CDC) (http://www.chinacdc.cn/en/), Health Commission of Hubei Province, and Wuhan Municipal Health Commission], and credible media reports in China (CCTV, People's Daily, CBN, YiMagazine). Data regarding H7N9 avian influenza in Shanghai, China, were obtained from our published literature (15).

Comparative Analysis

We compared the six key time nodes during the entire period from the detection of the first case to the launch of the health emergency response between COVID-19 in Wuhan City and H7N9 avian influenza in Shanghai. The key time nodes were as follows: hospitalization of the first case, hospital report to the local CDC, laboratory identification of the pathogen, technical recheck of the pathogen, confirmation, and notification of the pathogen, and launch of emergency disposal through the Chinese government.

We further evaluated three crucial periods during the public health emergency disposal of emerging infectious diseases: time taken by the hospital to report a case to the local CDC, time taken to identify the pathogen i.e., organization of the CDC laboratory to detect and recheck the pathogen, and time taken by the government to respond i.e., implementation of the emergency response once the pathogen is confirmed. Moreover, we calculated the number of days during each time node using the hospitalization time reference of the first case as the benchmark. The duration between detecting the first case and report the first death was also analyzed in the study.

The policy retrospective analysis approach was applied in this study, and no interviews, requiring recruitment and obtaining informed consent from humans were conducted. Information that can be disclosed to the public and/or is accessible in the public domain was sought in this study. Consequently, ethics approval was not required, and the study has no ethical implications associated with its design and conduct.

RESULTS

The comparison of three crucial periods between COVID-19 in Wuhan City and H7N9 avian influenza in Shanghai are shown in **Table 2** and **Figure 1**. The entire process of early surveillance and public health emergency disposal was 5 days longer in the case of COVID-19 than in the case of H7N9 avian influenza (46 vs. 41 days). The details regarding the comparative analysis using the set of six key time nodes and three crucial time periods are as follows.

TABLE 1 | Characteristics of the H7N9 avian influenza and coronavirus disease 2019 in China.

Characteristics	H7N9	COVID-19
Country of origin	China	China
First case in China	February 2013 in Shanghai	December 2019 in Wuhan
Viral genome	Negative segmented RNA	Positive single-stranded RNA
Pathogen identification	CDC, China; March 29, 2013	CDC, China; January 7, 2020
Human-to-human transmission	Limited	High
Genesis/source	Domestic poultry	Unclear (so far)
Method of diagnosis in China	Real-time PCR	Real-time PCR
Vaccines in China	Not yet available	Not yet available

TABLE 2 | Comparison of the key time nodes of emergency disposal between H7N9 avian influenza (2013) in Shanghai and coronavirus disease 2019 in Wuhan.

Key time nodes	Three crucial periods	Shanghai H7N9 avian influenza (2013)		Wuhan novel coronavirus pneumonia (2019)	
		Dates and events	**Cumulative time (day)**	**Dates and events**	**Cumulative time (day)**
1) Hospitalization of the first patient	Hospital to CDC reporting period	On February 21, the Fifth People's Hospital Affiliated to Fudan University (Shanghai) admitted a patient	1	On December 8, as confirmed by the Wuhan Health and Medical Commission on January 11 (based on *The Lancet* paper, Wuhan's first new coronavirus case was confirmed on December 1)	1
2) Hospital reporting to the local Center for Disease Control and Prevention (CDC)		On February 26, the Fifth People's Hospital Affiliated to Fudan University (Shanghai) submitted a report to the District CDC and requested for an epidemiological investigation	6	On December 27, the Hubei Hospital of Integrated Traditional Chinese and Western Medicine (Wuhan) reported four abnormal cases to the District CDC	20
3) Laboratory identification of the pathogen	Pathogen identification speed	On March 22, the P3 Laboratory of Shanghai Public Health Clinical Center initially identified it as a new avian influenza virus	30	On January 5, a novel coronavirus was initially identified by various institutions including Shanghai Public Health Clinical Center	29
4) Technical recheck of pathogen		On March 29, the National CDC isolated a new type of avian influenza virus from the patients' samples	37	On January 7, the National CDC isolated a novel coronavirus from the patients' samples	31
5) National confirmation of the pathogen	Government response period	On March 31, the National Health Administration confirmed that the pathogen was a new type of avian influenza virus	39	On January 8, the National Health Administration confirmed that the pathogen was a novel coronavirus	32
6) Local government launched emergency response		On April 2, Shanghai launched a level-three response to public health emergencies	41	On January 22, Hubei Province launched a level-two emergency response to public health emergencies	46
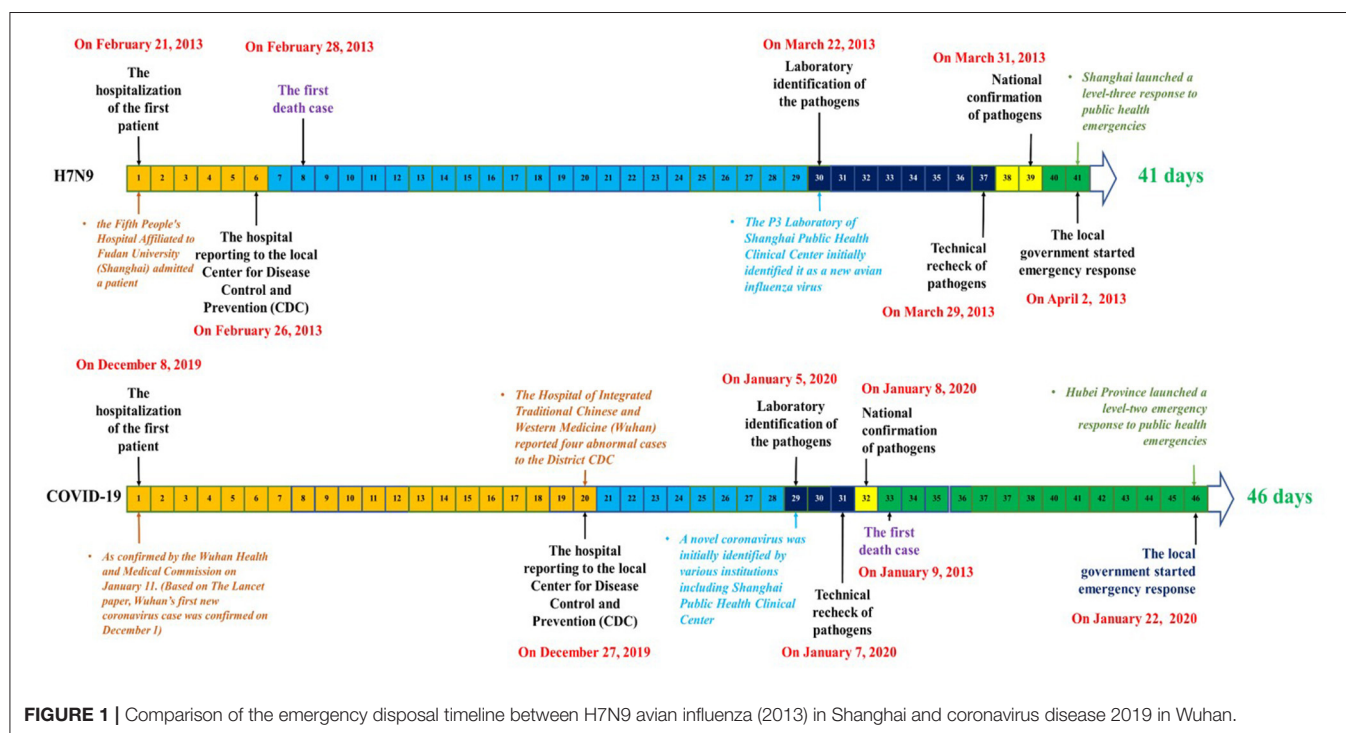
FIGURE 1 | Comparison of the emergency disposal timeline between H7N9 avian influenza (2013) in Shanghai and coronavirus disease 2019 in Wuhan.

Hospital to CDC Reporting Period
H7N9 Avian Influenza

The first patient was hospitalized at the Fifth People's Hospital of Shanghai affiliated to Fudan University on February 21, 2013. Subsequently, two patients were admitted (16, 17).

The doctor on duty in the emergency department observed that a paternal relationship existed between the follow-up case and the first case and believed that there was a possibility of transmission. Hence, in the early hours of February 26, 2013 at 1:10 a.m., he reported his findings to the doctor on duty who was also the chief of the infection department of the said hospital. He believed that the above situation was consistent with the possibility of clustered unexplained pneumonia cases and immediately called the attention of the administrators in charge of the hospital. Subsequently, the hospital gained expert consultation and undertook protective measures. At 2:30 a.m. of the same day, the hospital administrators contacted the chief administrative official of the local CDC by telephone and requested the start of epidemiological survey and sampling (18).

Coronavirus Disease 2019 (COVID-19)

The Wuhan Municipal Health Administration announced on January 11, 2020 that the first confirmed case of novel coronavirus pneumonia was detected on December 8, 2019 (18). A literature published in *The Lancet* reported that the first case was detected on December 1, 2019 (19). Based on the principle of caution, this article used December 8, 2019 as the onset time of the first case of the epidemic and considered that this patient was hospitalized in Wuhan Central Hospital at that time.

On the morning of December 26, 2019, Dr. Jixian Zhang, a doctor from Hubei Hospital of Integrated Traditional Chinese and Western Medicine in Wuhan City, observed an abnormality in a couple's lung computed tomography (CT) scan and an abnormality in their son's CT scan as well. The next day, the hospital reported four abnormal CT findings to the local CDC including another case (20).

Hence, the time taken by the hospital to report the first case of H7N9 (2013) in Shanghai and COVID-19 (2019) in Wuhan was 6 and 20 days, respectively.

Pathogen Identification Period
H7N9 Avian Influenza

The local CDC conducted an epidemiological survey and sampling at 4:00 a.m. on February 26, 2013 and informed the hospital at 10:30 a.m. that adenovirus, syncytial virus, Legionella, H1N1, highly pathogenic avian influenza virus, Mycoplasma, and seasonal influenza virus tested negative. The hospital subsequently sent the samples to the P3 Laboratory of Shanghai Public Health Clinical Center. On March 22, the Shanghai Public Health Clinical Center preliminarily confirmed the pathogen as a new type of avian influenza virus. On March 29, 2013, the National CDC isolated a new type of avian influenza virus from samples collected from patients.

COVID-19

The local CDC was unable to identify the pathogen on December 26, 2019 and subsequently sent the samples to various testing

institutions, including Shanghai Public Health Clinical Center and the Chinese Academy of Sciences (Wuhan Virus Institute). Various testing institutions had identified the novel coronavirus and the complete genome sequence between December 30, 2019 and January 5, 2020 (21). On January 7, 2020, the National CDC isolated a new type of coronavirus from the patients' samples (22).

Hence, the time taken to identify the pathogen in the cases of H7N9 (2013) in Shanghai and COVID-19 (2019) in Wuhan was 31 and 12 days, respectively.

Government Response Period
H7N9 Avian Influenza

On March 31, 2013, the National Health Administration confirmed that the pathogen was a new type of avian influenza virus. On April 2, 2013, the government of Shanghai launched a level-three response (the emergency disposal work is leaded and directed by the Municipal government in its own administrative region) to public health emergencies.

COVID-19

On January 8, 2020, the National Health Administration confirmed that the pathogen was a novel coronavirus. On January 22, 2020, the government of Hubei Province launched a level-two response (the emergency disposal work is leaded and directed by the provincial Government within its administrative region) to public health emergencies (23).

Hence, the time taken by the government to respond in the cases of H7N9 (2013) in Shanghai and COVID-19 (2019) in Wuhan City was 4 and 14 days, respectively.

We compared the government's emergency response process between outbreaks of Shanghai H7N9 avian influenza in 2013 and Wuhan COVID-19 in 2019. The time taken from the detection of the first case to the implementation of public health emergency response was 41 and 46 days for H7N9 avian influenza and COVID-19, respectively. The hospital to CDC reporting period was 14 days slower in the case of COVID-19 than in the case of H7N9 avian influenza. The time taken to identify the pathogen was 19 days faster in the case of COVID-19 than in the case of H7N9 avian influenza. Lastly, the time taken by the government to respond was 10 days slower in the case of COVID-19 than in the case of H7N9 avian influenza (**Figure 2**).

DISCUSSION

To the best of our knowledge, this was one of the few studies conducted in China to compare the strengths and weaknesses of public health emergency disposal between COVID-19 and H7N9 avian influenza. In this case-comparative study, the time taken to detect unknown pathogens had improved between the outbreaks of H7N9 avian influenza and COVID-19, whereas the time taken for hospitals to report a case to the local CDC and the government's emergency response was significantly increased.

In this study, we mainly investigated three crucial periods that influence the efficiency of emergency management of public health crises. During the emergency response process for H7N9 avian influenza (2013) in Shanghai, the maximum time was taken

FIGURE 2 | Comparison of three critical emergency disposal speed between H7N9 avian influenza (2013) in Shanghai vs. coronavirus disease 2019 in Wuhan.
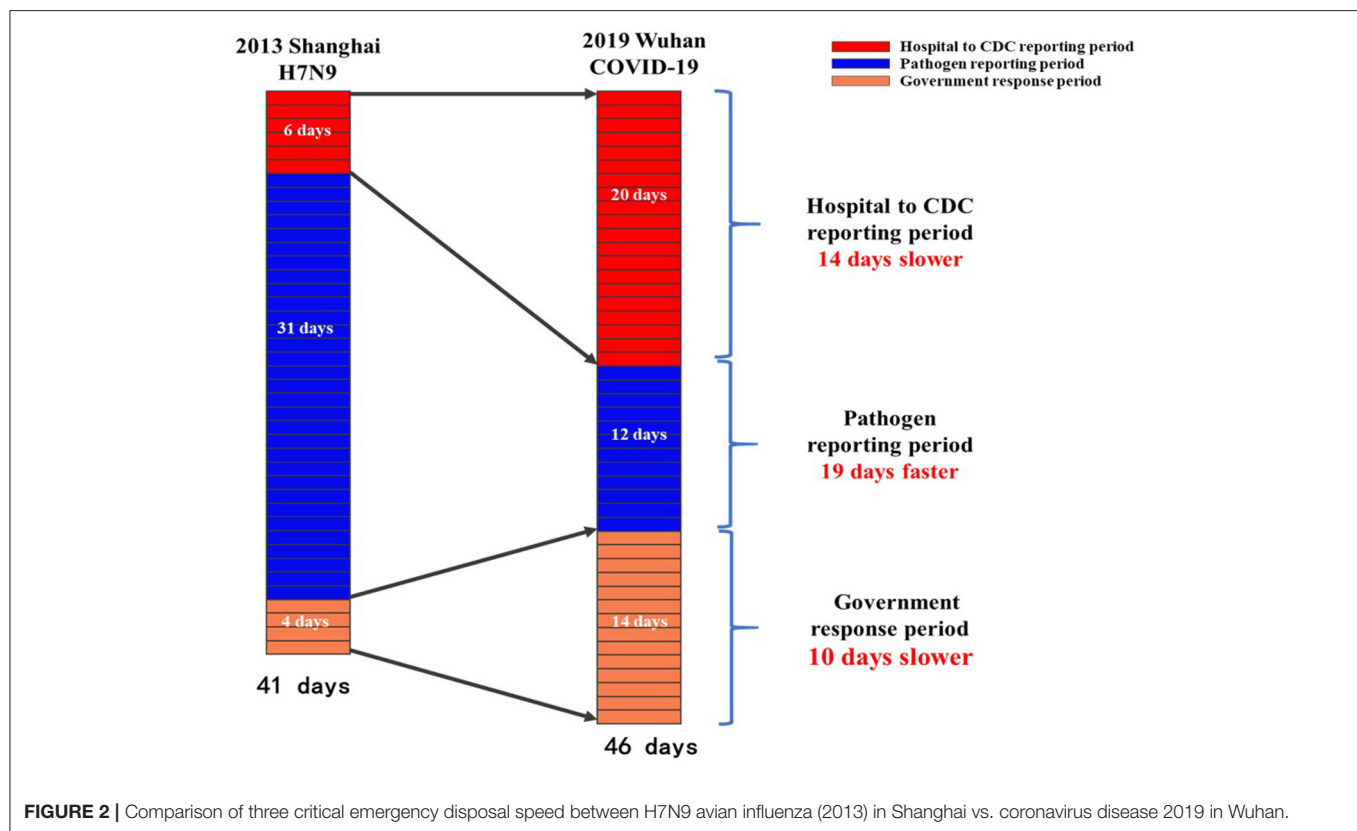
to technically identify and recheck the pathogen. The technical identification of pathogen took 24 days and the rechecking took 7 days, which accounted for 76% of the whole emergency process. In contrast, the time taken to technically identify and recheck the pathogen in the case of COVID-19 was reduced to just 12 days, accounting for 24% of the whole emergency process.

Laboratory identification was 19 days faster in the case of COVID-19 than in the case of H7N9 avian influenza, whereas the total disposal time was 5 days longer in the case of COVID-19 than in the case of H7N9 avian influenza. This could be attributed to the decrease in the reporting periods of certain hospitals and the increase in responding periods of the local governments. The time taken by the hospital to report a case to the local CDC was 14 days longer during COVID-19 than during H7N9 avian influenza (19 vs. 5 days, respectively). Furthermore, the response period of the local government launching emergency management was 14 days during COVID-19, which was 10 days longer than that during H7N9 avian influenza. Combining the hospital to CDC reporting period and government response period of H7N9 avian influenza with the pathogen identification period of COVID-19 would result in the entire epidemic control taking <22 days. Moreover, Hubei Province could thus launch an emergency response on December 30, suggesting that approximately 27 cases of COVID-19 would be detected in Hubei Province and the number of close contacts would be approximately 1350 by early March 2020. The Wuhan Municipal Infectious Diseases Hospital alone had 350 beds, which was sufficient to handle the

full admission. Subsequently, the local CDC also had sufficient capabilities to screen and isolate most of the patients in close contacts with the infected patients.

The 5-day longer emergency period during COVID-19 could possibly be attributed to the hospital to CDC reporting period and government response period constrained by the following objective conditions: (1) At the beginning stage of the epidemic, H7N9 appeared a larger threat. The interval between the first identified case and the first reported death was only 7 days (on February 28, 2013, the first death case was observed). For COVID-19, this interval was 32 days instead. On January 9, local medical institutions and disease control departments were instructed to speed up and implement isolation and precautionary measures (20). (2) Because of underreporting of cases considering the challenges in data collection and shortage of testing kits and reagents in Hubei Province. Furthermore, the local medical supplies, beds, and facilities were insufficient, which were even exacerbated by the lockdown of the province, preventing the reach of supplies from several other hospitals.

Indeed, in addition to this research, we also carried out several other studies simultaneously, comparing the government emergency response time of COVID-19 with the SARS in 2003 and the pandemic influenza A (H1N1) in 2009 respectively. The study found that the emergency response time of the COVID-19 epidemic (46 days) was 18 days longer than that of H1N1 (28 days). The speed of hospital reporting, pathogen identification, and government decision-making of COVID-19 were all slower

than those during HIN1 in particular. In the ongoing progress of the epidemic, the peak onset of H1N1 was about 4 weeks later than COVID-19, and the epidemic curve of H1N1 was flatter, which might be related to the timely emergency response of the HIN1 epidemic. The other study which compared the emergency response time between the SARS epidemic (127 days) and COVID-19, found that the latter was 81 days shorter. The hospital report time of these two epidemics was similar, but the pathogen detection time of SARS was more than 3 months longer than that of COVID-19, which reflected the level of pathogen detection in China has been greatly improved these years. After then, in following research, we will summarize the correlation between disposal time in different epidemics and their spread speed, attempt to explore the standard of emergency response procedures and their time constraints, so as to provide a reference for public health emergency response in the future.

This study has several potential limitations. First, the assessment coverage was at the city level; thus, comparison between the national level and the grassroots level was not assessed in this study. The grassroots level is the first gateway of public health emergency, and the effective measures and emergency responses taken by the grassroot level are considered important. Second, we used six-time nodes to evaluate the process of the government's emergency response, which is relatively limited when evaluating the possibility of an epidemic of major infectious diseases. Third, the data were based on China's official and authoritative reports, coupled with retrospective studies, which inevitably had information bias. Considering all these limitations, the findings should be interpreted with caution before additional studies are conducted.

CONCLUSIONS

The identification of the unknown pathogen has significantly improved in China between the outbreaks of H7N9 avian influenza and COVID-19. However, the speed of the hospital reporting an emerging infectious disease and the speed of the government decision-making were slow in COVID-19 epidemic, which might be one of the vital factors for widespread COVID-19 cases. These issues need to be addressed urgently to prepare for public emergencies to prevent and control future epidemics of emerging infectious diseases in China and the world.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

AUTHOR CONTRIBUTIONS

TZ, QW, and LL designed the project, processed and analyzed the data, and wrote the manuscript. YW, GB, and RD edited the manuscript. All authors revised the draft.

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Challenges Faced by Healthcare Professionals During the COVID-19 Pandemic: A Qualitative Inquiry From Bangladesh

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Background: The coronavirus disease 2019 (COVID-19) pandemic has caused increasing challenges for healthcare professionals globally. However, there is a dearth of information about these challenges in many developing countries, including Bangladesh. This study aims to explore the challenges faced by healthcare professionals (doctors and nurses) during COVID-19 in Bangladesh.

Methods: We conducted qualitative research among healthcare professionals of different hospitals and clinics in Khulna and Dhaka city of Bangladesh from May 2020 to August 2020. We conducted 15 in-depth telephone interviews using a snowball sampling technique. We used an in-depth interview guide as data were collected, audiotaped, and transcribed. The data were analyzed both manually and using QDA Miner software as we used thematic analysis for this study.

Results: Seven themes emerged from the study. Participants experienced higher workload, psychological distress, shortage of quality personal protective equipment (PPE), social exclusion/stigmatization, lack of incentives, absence of coordination, and proper management during their service. These healthcare professionals faced difficulty coping with these challenges due to situational and organizational factors. They reported of faith in God and mutual support to be the keys to adapt to adversities. Adequate support to address the difficulties faced by healthcare professionals is necessary for an overall improved health outcome during the pandemic.

Conclusion: The findings highlight the common challenges faced by healthcare professionals during the COVID-19 outbreak. This implies the need to support adequate safety kits, protocols, and support for both physical and mental health of the healthcare professionals.

Keywords: COVID-19, health professionals, workload, mental health, Bangladesh

INTRODUCTION

The COVID-19 outbreak was declared as a global pandemic on March 11, 2020 (1). Although social distancing is the most effective way to contain the outspread of this virus, this is not easy to implement for healthcare professionals who require direct contact with COVID-19 patients and puts them under a high risk of being infected themselves (2). Frontline healthcare professionals are particularly vulnerable during this pandemic owing to their commitment to contain the disease (3). As of October 15, 2020, there were around 4,797 COVID-19 cases for doctors and nurses with more than 100 deaths of physicians in Bangladesh (4). Besides physiological threats, such public health emergency affects the psyche of healthcare workers, including professional stress, fear of infection, and feeling helpless (5).

The number of doctors in Bangladesh government healthcare facilities is scarce (5.26 doctors/10,000 people). Hence, many healthcare professionals worked around 17 h, including long tele-counseling shifts each day (6). To mitigate this challenge, the government appointed an additional 2,000 doctors on May 2020 (7). Further, healthcare professionals faced acute shortage of masks, hand gloves, and personal protective equipment (PPE) to protect themselves from COVID-19 infection (8). Moreover, locally produced PPEs, masks, and other kits provided by the authority are being reported to be of low quality and unable to protect the medical workforce from being infected (9).

Healthcare professionals also suffered from insomnia, loneliness, sleep disorder, and mental depression as a result of the workload and related stress (10). They were experiencing anxiety attacks as well as frustration due to a lack of knowledge, environmental changes, and fear of infection both by themselves and by their family members (11). Currently, healthcare professionals are also bound to maintain physical distance from their family members to reduce the risk of contagion, which results in further psychological distress (12). Hence, a special attention to monitor the psychological issues of high-risk population exposed to COVID-19 becomes more essential (13).

When it comes to the challenges faced by the healthcare professionals of Bangladesh during COVID-19 pandemic, concerns raised from bad governance cannot be ignored. The number of PPEs provided by the government was insufficient for healthcare professionals, and they were mostly untrained regarding how to use them. This resulted into an alarming rate of infection among the medical workforce (14). Recent studies emphasize on strengthening the healthcare governance in Bangladesh by properly distributing healthcare facilities between urban and rural areas, public and private facilities, enhancing the role of media, increasing the recruitment of healthcare workers, and concentrating on the provision of necessary healthcare equipment such as intensive care units and oxygen supply (15–17).

Doctors are facing tremendous difficulties at work during the COVID-19 pandemic (18). Despite these obstacles, healthcare professionals have adapted to deal with the prevailing health crisis. A previous study (19) has shown that meditation, relaxation as well as music therapy can help to mitigate the daily stress. During the severe acute respiratory syndrome

(SARS) outbreak in 2005, healthcare professionals took some initiatives to cope with the stress associated with the pandemic. The coping mechanisms included avoidance of news about the SARS pandemic, small gatherings after work where problems can be shared as well as participating in other recreational activities (20). Proper training, PPE, and medical assistance are important to support healthcare providers (6); however, these are not available in Bangladesh. A number of studies have been conducted on COVID-19-related issues in Bangladesh; however, there are no qualitative studies on the challenges faced by healthcare professionals during the current COVID-19 pandemic. As qualitative research is known for generating rich information in health research (21), we attempted to address this research gap to get a more in-depth knowledge of the individual experiences, beliefs, opinions, behaviors, and feelings of the healthcare professionals during the pandemic (22).

THEORETICAL FRAMEWORK

We used the stress theories to understand the challenges healthcare professionals in Bangladesh are facing during the COVID-19 pandemic. The COVID-19 outbreak has generally caused public stress (23) as people go through a series of physical and mental challenges both inside and outside which affects their own subjective evaluations (24). Ursin and Eriksen (2004) provide a further explanation on how people go through stress during a crisis. The authors used the term "stress" to denote four different views, namely, "stress stimuli," "stress experience," "non-specific general stress response," and "experience of the stress response" (25). According to Cognitive Activation Theory of Stress (CATS) theory, people acquire knowledge when handling adversities, and a normal, well-balanced stress at such situations should be common. Response to stress is important as this provides the energy that enables them to fight against the odds. However, when there is a disparity between the expected and actual circumstance, the stress response mechanism starts struggling (26). While stress response is essential to face challenges, higher levels of sustained stress can lead to physical and mental disorders. We argue that the sustained workload and mental stress of the healthcare professionals during the pandemic originate an acquired expectancy referred to as "hopelessness"(27).

METHODS

An exploratory qualitative inquiry was employed to understand the in-depth knowledge of challenges dealt by health workers from Khulna and Dhaka city in Bangladesh from May to August 2020. Doctors and nurses who are willing and provided treatment at different hospitals and clinics in Bangladesh during the COVID-19 pandemic participated in this study. We selected 15 respondents for the in-depth interviews through the snowball sampling technique. The participants were recruited through referrals of healthcare professionals from our previous acquaintances. We used this technique as healthcare professionals who were willing to participate in this study were

extremely hard to find during the pandemic. The in-depth interview was conducted through telephone. We developed an in-depth interview guide to probe questions for the interview process. The items for the interview guide were generated through searching the relevant literature. Only contents related to the present study were considered, while pieces of pure medical literature were excluded from the review. The guide consisted of questions on barriers related to workload, severity of the illness and associated stress, availability and quality of PPE, COVID-19-related challenges, and coping strategies to manage the barriers.

SRR, TY, TBA, and MSI (academicians who completed their second degree) conducted the interviews and collected data through multiple sessions and with the convenience of the participants. The duration of each session was 30–40 min in general, and the interviews were recorded through an audio recording application/device, which was transcribed in the next stage. We used the follow-up questions to extract rich information during the interviews. Verbal probes such as repeating the ideas and phrases of participants and showing enthusiasm to a particular topic during the interviews were part of the probing strategy. Apart from the authors, two trained research assistants were appointed to manage the data collection and transcription. TBA and MSI independently coded the data from verbatim transcript as the process included the development of a code structure initially. The whole coding procedure was reviewed and finalized with the consent of all authors. We applied a deductive approach suggested by Miles and Huberman (1994) (28) using thematic analysis technique (29). The most recurring and significant quotes were selected to exemplify the predetermined themes. While analyzing, we focused on the meaning, context, phrases, frequency, and intensity of the statements of our participants. We analyzed the data both manually and using QDA Miner (version 5) software. The QDA miner is useful in managing a large volume of qualitative data extending the scope of manual analysis. It is largely used by researchers and experts for conducting qualitative research worldwide.

We maintained standard ethical protocols to conduct this research. The study protocol was approved by the person who blinded for peer review. At the beginning of the interviews, informed consent was sought from each participant after a briefing about purpose of the research was done. The identities of the respondents were kept confidential, and they assured that the information provided by them would only be used for academic research.

RESULTS

Characteristics of Study Participants

Fifteen respondents were included in the in-depth interview. The summary of the participants and their details are provided in **Table 1**.

Seven themes emerged from the unstructured interviews, i.e., workload, PPE, social acceptance, mental health, incentives, coping strategies, coordination, and direction of the respondents during the COVID-19 pandemic.

TABLE 1 | Sociodemographic profile of participants.

Age	27–58 years
Sex	Seven men and eight women
Marital status	All were married except one doctor
Study Area	Khulna (*n* = 9) and Dhaka (*n* = 5)
Institutions	Doctors and nurses from four medical facilities (KMC and GMCH, Khulna and DMCH and JBFH, Dhaka)*
Type of Institutions	Two private and two government hospitals
Occupation	Six doctors and nine nurses

Total participants were 15 (both doctors and nurses).
*KMC, Khulna Medical College (Khulna); GMCH, Gazi Medical College and Hospital (Khulna); DMCH, Dhaka Medical College and Hospital (Dhaka); JBFH, Japan Bangladesh Friendship Hospital (Dhaka).

High Workload

Participants indicated that the health sector faces a shortage of medical workers. Moreover, many registered doctors do no practice medicine, resulting in higher workload by the active medical workforce in public as well as in private facilities. In the private facilities, doctors were usually provided with a 1-day break each week. Doctors were working for long shifts in their working days and during holidays *via* telecommunication. For example, Participant 3 said,

> You are asking the doctors about their workload! When people were busy partying at the eve of Eid-ul-Fitr festival, we were working in the hospital. I had a shift even on Eid day. Moreover, I was diagnosed as COVID-19 positive on 15th of June 2020, which demands for at least a 21 days recovery process after being further tested as being COVID-19. But we cannot afford that luxury as the hospital does not have enough human resources. Consequently, I had to join my work right after accomplishing my recovery from the virus.

Apart from enduring tremendous physical pressure, excessive workload also leads to increased mental stress. Medical facilities also have few nurses, who had to work 16–17 h shift per day. Additionally, fear of infection prevented workers from joining their workplace. Participant 5 said,

> Since we have completed our nursing degree, so we are supposed to be psychologically well equipped to serve people in any medical emergency. But at the very beginning of the coronavirus outbreak, many of us suffered from a fear of infection and were too afraid to come to work. This decline in the regular number of nurses created too much workload for us.

Healthcare professionals who were younger and working in Dhaka-based hospitals reported of higher workload in this study. This might be due to a higher work assignment for younger people and a greater outbreak of COVID-19 in the capital city. When asked about workloads, Participant 12 shared with frustration,

> Dhaka is hit most severely during the first wave of COVID-19. It is the capital city of the country with 20 million population and the

largest international airport. People are landing here from countries with high infection rate every day and the disease is spreading like bushfire. We are admitting a large number of patients each day and having a really difficult time dealing with it.

Lack of PPE

Participants repeatedly pointed out that PPE supplied by their hospitals were either inadequate or of low-quality. Though the government demanded on the mass media that every hospital has been provided with the required numbers of PPEs, the fact on the ground was different. Especially, study participants in private medical facilities need to buy their own PPEs as they were not sure of the availability in the health facilities. Participant 1 corroborated the issue.

> *Despite the need to have a regular supply of PPEs, the hospital does not have enough of them in its possession. I have received one PPE per week from Japan Bangladesh Friendship Hospital, which is not sufficient. Consequently, I am needed to buy PPE at my expenses to ensure my safety during work. Another threatening fact regarding PPEs came into my notice from a number of national newspapers. Some corrupt businessmen are generating new PPE's from the ones that have been dumped as medical wasted in Keraniganj, Dhaka. This issue gave me quite a shock and made me question my oath to serve the mass people in any given situation.*

The PPEs provided by the authority were made of plastic-type material. The shortage of PPE also declined to some extent with time. An additional complaint came from the nurses that they had to face acute shortage of PPEs as doctors were the primary focus here and the need for an adequate supply of PPEs for nurses was relatively ignored. Participant 6 noted,

> *At the first slot, we were provided with a huge number of poor-quality PPEs which made the pandemic situation more vulnerable for health professionals like us. But as of now (month of June), we have a steady supply of good quality PPEs which can efficiently protect us from this virus. From my perception, there is no lack of PPE in the present condition.*

Low Social Acceptance

Social stigma was another challenge for the healthcare professionals during the COVID-19 pandemic. The neighbors perceived them as a nuisance and usually avoided communication for fear of infection. In some cases, landlords raised monthly house rents of the medical workers and evicted them from their property if they were tested COVID-positive. Sometimes, their maintenance of social distance became rather cruel, and this disturbed the healthcare professionals. Two of the statements represent this condition:

> Participant 3: *"Haha! Mass people always perceive us doctors as "butchers" in this country. We are shown some respect over social media posts, but there is no respect for doctors in the real-world. Red flags are used to mark the zone containing COVID positive patients, but from my perspective, these flags are playing the role of barriers. While we need more psychological support from general*

people, working within the red zone has completely excluded us from society."

> Participant 5: *"Actually, I feel deeply disturbed when I talk about the issue of social acceptance. When I started serving contagious patients during this pandemic, people of my community treated me in a way which made me feel like I was a raped woman… (Crying). But I have taught myself to endure that pain and work as a frontline fighter against this deadly virus."*

Parents of healthcare professionals remained concerned about their children working in such a risky environment. They often tried to bargain with them to stay home, but it was merely parental concern, and the participants continued work after pacifying them. Generally, their relatives maintained a social distance and refrained from visiting their houses. But participants considered this as positive to ensure the safety of both their relatives and their family members.

Mental Health Problems

People working in the medical sector are trained to think and act steadily in any medical emergency. Regardless of that training, participants mentioned that they had to cope with different psychological challenges, including anxiety, depression, insomnia, and fear of sudden death during the COVID-19 pandemic. Participant 2 said,

> *Being a doctor has taught me to have full control over my mind. Despite that control, the current pandemic makes me anxious sometimes as many doctors are being infected during their service toward COVID-19 patients. There is one incident worth mentioning in this context. Witnessing the death of patients is part of the job for us, but I had to witness the death of a medical doctor in Sylhet due to COVID-19, which was a first for me. It was the most shocking thing during my lifetime working experience. After this experience, I started having trouble sleeping.*

Healthcare givers serve in an atmosphere where the fear of infection prevails at its largest. Despite that, participants were more concerned about family members being infected by them rather than themselves being infected, leading to further mental stress. Participant 4 mentioned,

> *To me, psychological pressure mainly consists of anxiety regarding the safety of my family. I am a widow, and my daughters are dependent on me both economically and for the sustenance of their daily lives. This familial condition puts me in a lot of pressure and forces me to think about what would happen to my daughters if I was diagnosed as a corona virus-positive and died. The constant thought of leaving my daughters all alone in this world is quite stressful.*

Witnessing sudden death of colleagues created a feeling of helplessness among the healthcare professionals, leading to many of them to experience insomnia. The lack of appreciation by colleagues also caused psychological pressure. One of the nurses mentioned that doctors do not appreciate them enough.

> Participant 6: *We work with extreme fear and risk of infection risking our lives, but we get no appreciation. People think only*

doctors are contributing to save lives. We (nurses) are always ignored and underpaid in this country. It's nothing new.

Lack of Incentives

All participants were aware that there was no extra-incentive for them despite working extra hours. Some incentives were promised by the government, such as providing treatment cost in case of infection and providing an isolation room to ensure safe inhibition. But none was implemented in the real life. Further, participants strongly believed that these initiatives were not going to be implemented shortly. For example, Participant 3 said,

Government announced that if anyone got infected by coronavirus during their service, the authority would provide some money for treatment. Surprisingly, I did not receive any monetary support to bear my treatment cost when I was diagnosed as COVID-positive. Their announcement is void as always, and it is never going to be implemented. Though we are getting two basic salaries of around 50,000, which is not enough for us.

While the incentives provided by the authority for the employees in the government facilities were not satisfactory, the condition of the healthcare professionals working in private facilities was even worse. There was no monetary incentive for the healthcare professionals working in private facilities if they got infected or died during their service. The participants were depressed about this discrimination between public and private employees. Moreover, they were also deprived of basic amenities such as break between work shifts or provision of meals raising frustrations. Participant noted,

We have seen that roster system is in place to arrange the shifts of the health professionals in the government hospitals. As a result, government doctors get seven days off after completing a seven-day shift with Corona patients. Unfortunately, we, the private clinic workers, do not get any incentive like that. I don't even get my meals from the hospital.

Lack of Coordination and Direction

The WHO and government guidelines were changing continuously given the disease is new and previous knowledge is little. Consequently, doctors remained uncertain about the line of treatment. These uncertainties created additional mental stress for medical professionals.

The participants reported that patients were unaware of any safety protocols. COVID-19-positive patients often come to medical facilities to receive standard medical consultation, which put COVID-negative patients as well as the medical workers at-risk. In several cases, doctors and nurses got infected because patients did not reveal that they were COVID-19-infected. A high-level coordination failure was prevalent in the healthcare administrations.

Moreover, healthcare workers were dissatisfied about some discriminatory initiatives taken up by the authority. Participants mentioned the case of the bank sector, where employees worked for only 20 days in April and May. In contrast, healthcare professionals did double or triple shifts, which was frustrating. Besides, they did not have any training regarding

how to function correctly in a virus outbreak. It was also perceived that the authority involved more administrators and fewer specialists to tackle down this pandemic. For example, Participant 3 mentioned,

I want to mention one more issue here. It is needed to create a committee containing doctors as well as virologists who are specialized in providing guidelines in the context of how to handle the current COVID-19 situation in Bangladesh best. Instead, the government has created a task force containing DCs, UNOs and other administrative personnel who possess no knowledge about the virus.

Coping Strategies

All of the participants expressed that belief upon God kept them relaxed. Support from family members and colleagues was also an essential coping mechanism. The healthcare professionals maintained regular conversations with colleagues maintaining social distance and tried to be benevolent with each other in their workplace. This supportive environment helped them a great deal in reducing their mental stress. Keeping their sacred oath in mind, they were always more concerned about their patients than their well-being. This concern for the well-being of mass people served as a coping mechanism on its own. For instance, Participant 4 said,

I cope with the challenges faced in my workplace with the support of my family, colleagues and a firm belief on the almighty's plans for all of us. The support of my close ones and trust in the almighty provides me with a sense of mental strength encourages me to stay positive any crisis. I also take mental notes that this is my job, and I must do it. If I become nervous in performing my duties, then how would the general people survive?

Apart from taking mental support from friends and families, healthcare professionals tried to follow every medical rule and regulation in their ability to keep safe from infection. The study protocol was approved by the Ethical Clearance Committee of Khulna University. Other participants reported meditation as means to increasing mental strength. Overall, participants put faith in a greater force in this crisis and keep reminding themselves that as they were working for the well-being of humanity.

DISCUSSION

Our results showed that frontline healthcare professionals in Bangladesh had an increased workload during this crisis and a potential system failure in the healthcare sector. Lack of sufficient healthcare workers, knowledge about the virus, and basic training were some of the reasons leading to excessive workload, which consequently gave rise to psychological stress. This finding is consistent with some of the existing literature (30, 31). A previous study also showed that excessive work pressure was responsible for mental distress, insomnia, physical weakness as well as fear of infection of the healthcare professionals (32). Our study also focused on the lack of quality PPEs prevalent in the healthcare facilities. It was reported that the insufficiency

consequently led to an increasing rate of infection among healthcare professionals in Bangladesh. Several studies have found that insufficient PPE triggered the spread of the viruses among healthcare professionals (33, 34). Besides, wearing PPE for a long time was a crucial challenge for participants, subsequently resulting in drinking less water than necessary, which might have affected their immunity (35).

Coordination failure was prevalent among different administration sections in each facility where the respondents worked, resulting in a chaotic environment. Consequently, both doctors and patients were unsure about the protocols needed to maintain safety, which further increased the risk of infection. Insufficiency of medical staff and equipment was common, resulting in excessive workload and safety hazard (36). This workload and constant fear of infection both for themselves and for their family members put participants under substantial psychological stress (11). Social acceptance from neighbors, colleagues, and peer groups could act as a lifeline in removing this psychological stress. But the social reaction of most cases was still adverse toward the medical workforce, and they were shunned from their social life. Hence, the experience of medical professionals was pretty challenging during the pandemic. They still took coping strategies such as putting their faith in God, treating each other with kindness, and soothing conversation with a peer group to cope up with the stress to some extent.

We observed that most of the participants in this study required adequate protective supplies and proper rest, which is consistent with the present study (37). Psychological stress faced by healthcare professionals during public health emergencies included constant worries about infecting children and parents of an individual, fear of death, anxiety about critical patients, and personal danger (38, 39). Healthcare professionals felt anxious when their colleague was infected by COVID-19 (9). We also observed that healthcare professionals who had children were emotionally distressed to maintain distance from their loved ones due to a higher risk of being infected by COVID-19. The finding was similar to another previous research (20). Nurses expressed dissatisfaction with the workload as they are not appreciated enough, although it is evident that they often provide quality healthcare services like the doctors (40).

Healthcare professionals also faced stigma from their neighbors and relatives. Neighbors perceived that the health workers carry a higher risk of infection from their exposure to patients. As a result, healthcare professionals were shunned from society and treated harshly, which sometimes demotivated them to serve patients. However, previous study documented that healthcare professionals need social support from their family members, relatives, and neighbors. Being devoid of that, support can result in anxiety and depression for healthcare professionals (41, 42). We predict that incentives such as economic support, constant supervision, sufficient protective equipment, and adequate workforce could motivate health workers to contribute more during pandemic situations. Unfortunately, Bangladeshi healthcare professionals are mostly deprived of these facilities. Some of the infected healthcare professionals of this study mentioned that though the government announced some financial incentives, they did not receive it in reality.

When comparing our finding with the SAARC countries, we see some striking similarities. These countries already have a vulnerable economy characterized by weak medical infrastructure that rarely managed to provide its people with sufficient medical care, at least providing the healthcare professionals with necessary psychological help (43). Inadequate PPEs, social stigma, and being victims of violence added extra psychological stress for healthcare professionals in the middle of their already hectic schedule (44). Besides, healthcare professionals from different age, gender, and socioeconomic background suffer from different psychological issues. A specialized set of interventions are required for healthcare professionals depending on their mental health condition (45). Although the National Health Policy of Bangladesh (2011) promises an adequate supply of logistics and manpower in government healthcare facilities, and coordination between different healthcare services-related departments (46), the reality is different. We observed that the lack of coordination and skilled manpower still remains a key problem affecting the healthcare services quality in the country, which corresponds to the existing literature (47, 48).

The spread of an epidemic can cause psychological trauma for healthcare professionals (10, 35). Therefore, effective coping strategies are required. Studies suggest that self-care, confidence, teamwork, and gathering among coworkers are some practical ways to alleviate mental pressure, work stress, and posttraumatic experiences amid emergencies of caregivers (49, 50) which was consistent with the results of this study. The stress theories also argue that the sustained response to stress for the healthcare professionals may lead to physical illness through proven pathophysiological ways (51, 52). We suggest as the pandemic prevails, healthcare professionals will face further physical and mental adversities; therefore, they will need a special attention to avoid this helpless situation.

STRENGTHS AND LIMITATIONS

A strength of this study is using the exploratory qualitative inquiry to analyze what challenges the healthcare professionals in Bangladesh are facing and how they managed these adversities during the COVID-19 pandemic. However, the large volume of data was difficult to collect, analyze, and maintain. The researchers put a greater amount of effort and time to offset the limitations. We followed the consolidated criteria for reporting qualitative research (COREQ) checklist for our in-depth interviews and for reporting this study. The interviews were not restricted to specific questions and topics which helped producing rich and detailed information. We used the snowball sampling technique as we were unable to find a large number of healthcare professionals who were willing to allow us sufficient time and cooperation during the pandemic. Because of the hectic schedule of the healthcare workers, interviews had to be kept short in some cases. However, we managed to reach the desired number of participants required to complete the study. As qualitative research relies on the depth of information instead of the number participants, 15 healthcare professionals who participated in this study were enough for

data saturation. Besides, executing a qualitative study through telephone interviews had its own limitations, although the researchers put their best effort to respond to the situation. We acknowledge that direct observation and methodological triangulation might have provided further insight into the topic.

CONCLUSIONS

The present study explores the challenges faced by healthcare professionals during COVID-19 pandemic in Bangladesh. We found that insufficiency of medical staff as well as medical equipment was common and resulted in increased workload. Apart from this, shortage of PPE, fear of being infected, social exclusion, and mismanagement contributed further to put the healthcare professionals in adversity. Although the National Health Policy of Bangladesh (2011) recommends enhancing skilled manpower and logistic support, we found the actual scenario to be different. Especially during the COVID-19 outbreak that put the healthcare sector into unprecedented challenge, the promised coordination and support in the healthcare sector rather reflects a disparity between the policy and the practice. Despite the recently introduced National Infectious Diseases Act (2018), lack of a standardized COVID-19 protocol kept the medical professional under constant risk of infection and mental pressure. We conclude that the healthcare professionals need to be supported with adequate resources for both physical and mental health. While workloads need to be lessened, a proper coordination and access to information as promised in the National Health Policy during this public health emergency should be put in practice to ensure quality healthcare services.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/**Supplementary Material**, further inquiries can be directed to the corresponding author.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Ethical Clearance Committee, Khulna University. Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

AUTHOR CONTRIBUTIONS

SR conceived the idea. SR, TY, TA, and MI analyzed the data. SR and TY drafted the manuscript. SR, SI, HG, and PW critically reviewed and approved the final version of the manuscript.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpubh.2021.647315/full#supplementary-material

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Psychological Distress and Happiness of Men Who Have Sex With Men and Transgender People During the Coronavirus Disease-19 Pandemic: Is There a Need for Public Health Policy Intervention?

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Since the global onset of COVID-19 in early 2020, the disease has significantly impacted mental health. This impact is likely to be further exacerbated for groups who were already marginalized. This paper shares results from a broader study of men who have sex with men (MSM) and transgender people in Bali, Indonesia and includes a focus on psychological distress and happiness during the COVID-19 pandemic; applying sociodemographic and epidemiological characteristics as potential mediators. Psychological distress and the level of happiness were measured by The Kessler Psychological Distress (K10) and the Subjective Happiness Scale (SHS). A cross-sectional survey was conducted from July to September 2020. Of the 416 participants, complete data were available for 363 participants. The majority of participants were aged 26–40 years, currently single, were born outside Bali, were currently living in an urban area, and over one-third were living with HIV. While all were MSM, the majority identified as homosexual/tend to be homosexual (71.3%), however 54 (14.9%) identified themselves as heterosexual. The majority (251, 69.1%) reported moderate to very high psychological distress during the COVID-19 pandemic. The binary logistic regression analysis identified five factors to be significantly associated with higher psychological distress: being a student, reporting higher levels of stigma, had ever experienced discrimination, felt better prior to the COVID-19 pandemic, and less happy than the average person. When homosexual were compared with heterosexual participants, those who identified themselves as being homosexual reported significantly lower psychological distress compared to those identified themselves as heterosexual, which may be associated with these participants not disclosing their status as MSM and the stigma around MSM. Those who considered themselves to be less happy than the average person

(316, 87.1%) were more likely to live with a partner and to report moderate to very high psychological distress. Based on the findings, interventions should focus on strategies to reduce stigma, provide non-discriminatory services, and improve access to essential health services.

INTRODUCTION

The first COVID-19 case in Bali was identified amongst an international tourist in February 2020, with community transmission increasing from June 2020 onwards (1). In December 2020, the cumulative cases were at 16,947 with a case fatality rate of 2.95% (around 500 deaths) (2). As per 15th of August 2021, the cumulative cases were 96,027 of which 85.28% (81,892) are recovered and 2,709 (2.82%) deaths (3). Throughout this pandemic, the government; related stakeholders, individuals organizations, and businesses throughout Indonesia have implemented control measures to reduce transmission of COVID-19. The control measures include stay-at-home orders, physical distancing, wearing face masks, and regular hand washing (4). In July 2020, the Bali Government announced a plan to resume all activities in the island *via* a "New Era of Life Order Protocol" that involved a strategy of reopening across three stages (1). However, due to the increase number of COVID-19 cases since July 2021, the Government of Indonesia has introduced level 4 of COVID-19 restriction known as emergency PPKM (Pemberlakuan Pembatasan Kegiatan Masyarakat) in order to restrict public activities and to reduce the COVID-19 transmission (5). The COVID-19 pandemic has affected mental well-being worldwide, even though individual mechanisms for coping may differ. Researchers have investigated transmission pathways for COVID-19, treatment options, impacts upon physical, and mental health amongst the general population, patient groups, and health providers (6). Evidence regarding the effects of the pandemic on mental health of marginalized groups remains limited, especially for MSM and transgender, who exist as hidden communities in many societies. In Indonesia, MSM and transgender women (known in Bali as "waria") report difficulties associated with social stigma, violence, persecution, and other legal challenges which restrict the development of inclusive public policy (7) that leads them to become 'hidden populations' who are difficult to reach (8). Although MSM and waria are "accepted" in some parts of Indonesia, they continue to experience rejection due to family, cultural, and religious reasons in many regions of the country.

Several studies have been conducted to explore the well-being of MSM and transgender people globally during the COVID-19 pandemic. A study conducted in Brazil in 2020 found that 7.9% of MSM and transgender participants to report low psychological well-being (9), whereas research conducted in Mexico suggested high levels of depression among MSM and transgender women during the COVID-19 pandemic when compared to before the pandemic (10). A systematic review from available evidence revealed that overall MSM and transgender individuals suffered from disproportionate negative influence of stressors linked to the pandemic due to pre-existing vulnerabilities (11). The findings also suggested MSM and transgender peoples vulnerability were increased by mental health, economic deficit, and physical vulnerability during the pandemic (11). To the best of our knowledge, there was no literature available specifically focusing on happiness amongst MSM and transgender people during the COVID-19 pandemic. To date there have been a few published studies exploring the effect of COVID-19 on mental health in Indonesia, however these focus on the general population. A study of Indonesian adults (*n* = 8,000+) found levels of anxiety were highest among younger people and females. A study of healthcare workers (*n* = 227) found more than one third of respondents reported high levels of anxiety which was attributed to lower resilience. During non-pandemic times, MSM and transgender individuals in Indonesia have been found to be more likely to experience mental health issues compared to the general population (12). For example, a study in Bali in 2015 reported a high level of social anxiety and depression amongst MSM (13). To the best of our knowledge there have been no published studies focusing on psychological distress and happiness conducted among these communities in Bali during the current pandemic.

This paper examines the psychological distress and happiness of MSM and transgender people in Bali during the COVID-19 pandemic. Factors related to psychological distress and happiness amongst MSM and transgender people in Bali during the COVID-19 pandemic were measured, and comparisons made to participants' self-perception of these measures prior to the pandemic.

METHODOLOGY

Study Design, Participants, and Procedure

Data presented in this paper is part of a broader community-engaged research study exploring attitudes, behaviors and experiences of the MSM and transgender communities in Bali, Indonesia (14). In the third phase of this study, a cross-sectional survey was hosted on the Qualtrics platform from 6th of July to 28th of September 2020. Most participants completed the online survey independently; however research partners read the survey aloud for those with low literacy levels. Given the estimation of the MSM population in Bali, of around 14,000 adults, to obtain 95% confidence level and 5% precision (margin of error), the required sample for the survey was calculated to be 374 respondents (15). The detail of survey methodology can be found in the protocol paper of the project (14).

A convenience sample of participants were recruited, assisted by 10 Balinese-based research partners who were staff of

various non-government organizations (NGOs) focusing on the health of marginalized communities including MSM and transgender people. Partner-driven sampling technique was used to recruit participants. As part of this community-engaged research the research partners have been involved in each stage of the research. These partners recruited participants purposively and *via* snowballing technique. Social media was also used to recruit participants. Each research partner recruited at least 40 participants within four rounds of data collection. Interested participants were provided the survey link *via* email or WhatsApp. Eligible participants were aged 18 years or older, Indonesian citizens who had lived in Bali for at least 6 months and intended to remain there for at least the next 6 months, identified as male or transgender (waria), and had engaged in sexual activity with a man or transgender person in the last 6 months.

All survey responses were anonymous and data stored on a secure University network. Broadly, the survey captured various attitudes, behaviors, and experiences of MSM and transgender, however this paper focuses on data relating to: sociodemographic characteristics, the Kessler Psychological Distress (K-10) scale (16), and the Subjective Happiness Scale (SHS) (17). The full survey is available on request to the corresponding author.

Measures

The structured online survey included previously validated questions and scales (14, 18–21). It was originally written in English and then translated into Bahasa Indonesia. Face and content validity testing was conducted with the research partners and Indonesian public health experts.

Demographic characteristics including age, gender, sexual identity, marital status, education level, daily activities, place of birth, and residential district were collected. Other items included family attitude toward MSM/transgender status, social networking before and during the COVID-19 pandemic, number of regular partner(s), stigma [using the 12-item short version of the HIV stigma scale (21)], discrimination [based on previously validated measures (22)], and HIV status.

Psychological Distress Assessment

The K10 scale was used to measure psychological distress (16). The ten-item scale is used widely for epidemiological and clinical purposes as a simple self-report tool to identify persons who require further assessment for depression and anxiety (16). Scores range from 1 to 50 and were collapsed into four categories: low (10–15); moderate (16–21); high (22–29); and very high (30–50).

As this survey was administered during the COVID-19 pandemic, participants were also asked to reflect how they were feeling, in terms of psychological distress, prior to the pandemic (1 year ago). Three responses were provided: (1) the same; (2) previously my feeling/condition was better compared to now; and (3) previously my feeling/condition was worse compared to now.

Happiness Assessment

The Subjective Happiness Scale (SHS), is a four-item self-report scale used to assess a person's overall happiness (7-point Likert scale) (17). The first two items ask participants to categorize themselves using an absolute rating as being a happy person and a happiness rating relative to their peers. The two last items present short phrases describing happy or unhappy people and ask respondents to identify the degree to which these scenarios best describe them (17). An overall score is calculated by averaging the answers. Scores range from 1 to 7, with higher scores reflecting greatest happiness (17). This scale has been used and validated in 14 different studies with over 2,700 participants (17).

Data Analysis

Data were analyzed using SPSS v.26. Descriptive analyses were used to describe the research variables. Mean, standard deviation, and range were calculated for continuous variables (age) and for each scale (K10 and SHS). For inferential analyses, K10 was categorized as low psychological distress (score 10–15) and moderate to very high (score 16–50) (23). SHS was categorized as less happy than average person (score <5.6) and happier than average person (score ≥ 5.6) (17). Initially, variables associated with psychological distress were identified by comparing the two categories on the K10 scale and the two categories on the SHS scale using a chi-square test. Statistical significance was set at $p < 0.05$. Subsequently, binary logistic regression reported the strength of association, which generated odds ratio (OR) and 95% confident interval (CI). Multivariate analyses provided adjusted OR (AOR), with 95% CI, by adjusting for demographics (gender, age, sexual identity, education level, daily activity, place of birth, and residential district) and epidemiological characteristics (family attitude toward MSM/transgender status, social networking before and after COVID-19 pandemic, number of regular partners, stigma, discrimination, and overall feeling/condition before COVID-19 pandemic).

Ethical Approval

The study was approved by the Human Ethics Committee, Faculty of Medicine, Udayana University/Sanglah Hospital, Bali, Indonesia (No: 2521/UN14.2.2.VII.14/LP/2019) and the Curtin University Human Research Ethics Committee, Australia (HRE 2019-0759). This research was carried out in accordance with the Declaration of Helsinki with written informed consent obtained from all participants.

RESULTS

Responses were received from 416 MSM and transgender individuals living in Bali, Indonesia and complete data were available for 363 participants. The mean age (SD) of participants was 32.46 (7.83) years and 68.3% were aged 26–40 years. The majority identified as male (72.5%) and indicated their sexual identity to be homosexual/tend to be homosexual (71.4%). More than half of the participants had completed senior high school (52.3%) and over half were working full time (55.6%). Most participants were born outside Bali Province (58.9%) and lived

in urban areas (85.7%). Nearly 30% of participants reported they were either married or living with a partner. Just over a half of participants (56.5%) had not disclosed their identity as either MSM or transgender to their family members. Around 35% were living with HIV (**Table 1**). Individual items for psychological distress and happiness are described in **Tables 2**, **4**.

Psychological Distress

The mean (SD) K10 score was 18.72 (5.7); with scores ranging from 10 to 40. Based on the four categories of psychological distress, participants were most likely to report moderate psychological distress (156, 43.0%). Only 3.9% ($n = 14$) participants reported very high psychological distress while 30.9% ($n = 112$) reported low levels of psychological distress (**Table 2**). After collapsing psychological distress into two categories, 69.1% ($n = 251$) of participants reported moderate to very high psychological distress.

Univariate analyses revealed eight variables (sexual identity, primary daily activity, family attitude about the sexual identity, number of regular partner, experience of stigma, experience of discrimination, overall feeling before the COVID-19 pandemic, and level of happiness) to be significantly associated with psychological distress (**Table 3**).

Multivariate analyses found students (as the primary daily activity) were four times (AOR = 4.009, 95% CI: 1.530–10.503, and $p = 0.005$) more likely to report moderate to very high psychological distress compared to participants working full-time. Reporting higher (AOR = 1.901, 95% CI: 1.140–3.170, and $p = 0.014$) compared to lower stigma; ever having experienced discrimination (AOR = 2.464, 95% CI: 1.464–4.147, and $p = 0.001$) compared to never; feeling better before COVID-19 pandemic (AOR = 2.404, 95% CI: 1.388–4.161, and $p = 0.002$) compared to feeling the same; and self-identifying as less happy than the average person (AOR = 3.962, 95% CI: 1.980–7.927, and $p = 0.000$) were all significantly associated with higher psychological distress. Conversely, identifying as homosexual (AOR = 0.409, 95% CI: 0.170–0.984, and $p = 0.046$) was significantly associated with lower psychological distress compared to participants who identified themselves as heterosexual/tend to be heterosexual (**Table 3**).

Level of Happiness

The mean (SD) SHS score was 4.74 (0.88), with score range 4.5 (**Table 4**). Based on two categories, most participants (316, 87.1%) self-reported to be less happy than the average person with, only 12.9% ($n = 47$) of participants considering themselves to be happier than the average person. None of the participants who identified themselves as heterosexual felt they were happier than the average person.

Univariate analyses found being a student, living with a partner, having more than one regular partner, and having moderate to very high psychological distress were significantly more likely to be associated with reporting to be less happy than the average person (**Table 5**). Multivariate analyses found only two associations to remain significant. Those living with a partner (AOR = 15.610, 95% CI: 2.074–117.471, and $p = 0.008$) and participants with moderate to high levels of psychological

TABLE 1 | Characteristics of the study participants.

Characteristics	Total, n (%)
Total participants	363
Age (in years)	
Mean (±SD)	32.46 (7.83)
Range	41
Age groups	
18–25	63 (17.4)
26–40	248 (68.3)
41–60	52 (14.3)
Gender	
Male	263 (72.5)
Transgender/waria	100 (27.5)
Sexual identity	
Heterosexual/tend to be heterosexual	54 (14.9)
Homosexual/tend to be homosexual	259 (71.3)
Bisexual	50 (13.8)
Education level	
No or elementary school	39 (10.7)
Junior high school	61 (16.8)
Senior high school	190 (52.3)
Diploma or higher	73 (20.1)
Marital status	
Single (not married, widow)	262 (72.2)
Married	30 (8.3)
Living with a partner	71 (19.6)
Daily activities	
Regular/full time job	2,020 (55.6)
School/college	46 (12.7)
No job/no school	58 (16)
Home duties/others	57 (15.7)
Place of born	
Bali	149 (41)
Java	133 (36.6)
Others	81 (22.3)
Current living area	
Urban	311 (85.7)
Rural	52 (14.3)
HIV+ status	
Yes	130 (35.8)
No	218 (60.1)
Do not know/have never tested for HIV	15 (4.1)
Family attitudes	
All accept	97 (26.7)
All/some reject	61 (16.8)
Do not know about MSM status	205 (56.5)

distress (AOR = 4.155, 95% CI: 2.150–8.032, and $p = 0.000$) were more likely to rate themselves as less happy than the average person (**Table 5**). Interestingly, in the multivariate analysis, a significant association was also found between happiness and those who felt better before the COVID-19 pandemic (AOR =

TABLE 2 | Level of psychological distress among the study participants (*n* = 363).

Anxiety and depression checklist (K10) (last 4 weeks)

About how often did you feel tired out for no good reason?

None	134 (36.9)	Most of the time	7 (1.9)
A little of the time	176 (48.5)	All the time	0 (0.0)
Some of the time	46 (12.7)		

About how often did you feel nervous?

None	149 (41.0)	Most of the time	7 (1.9)
A little of the time	150 (41.3)	All the time	2 (0.6)
Some of the time	55 (15.2)		

About how often did you feel so nervous that nothing could calm you down?

None	180 (49.6)	Most of the time	4 (1.1)
A little of the time	139 (38.3)	All the time	0 (0.0)
Some of the time	40 (11.0)		

About how often did you feel hopeless?

None	141 (38.8)	Most of the time	6 (1.7)
A little of the time	165 (45.5)	All the time	2 (0.6)
Some of the time	49 (13.5)		

About how often did you feel restless or fidgety?

None	100 (27.5)	Most of the time	8 (2.2)
A little of the time	186 (51.2)	All the time	1 (0.3)
Some of the time	68 (18.7)		

About how often did you feel so restless you could not sit still?

None	142 (39.1)	Most of the time	5 (1.4)
A little of the time	156 (43.0)	All the time	1 (0.3)
Some of the time	59 (16.3)		

About how often did you feel so depressed?

None	169 (46.6)	Most of the time	6 (1.7)
A little of the time	142 (39.1)	All the time	1 (0.3)
Some of the time	45 (12.4)		

About how often did you feel that everything was an effort?

None	66 (18.2)	Most of the time	28 (7.7)
A little of the time	104 (28.7)	All the time	47 (12.9)
Some of the time	118 (32.5)		

About how often did you feel so sad that nothing could cheer you up?

None	124 (34.2)	Most of the time	9 (2.5)
A little of the time	166 (45.7)	All the time	6 (1.7)
Some of the time	58 (16.0)		

(Continued)

TABLE 2 | Continued

About how often did you feel worthless?

None	187 (51.5)	Most of the time	7 (1.9)
A little of the time	131 (36.1)	All the time	0 (0.0)
Some of the time	38 (10.5)		

How do you feel/the condition that you conveyed before the COVID-19 pandemic (1 year ago)

The same	113 (31.1)	Previously my feeling/ condition was better	226 (62.3)	Previously my feeling/ condition was worst	24 (6.6)

K10 score (total)

Mean (SD)	18.72 (5.7)
Range (minimum–maximum)	30 (10–40)

Level of psychological distress (K10 categories)

Low (score 10–15)	112 (30.9)	High (score 22–29)	81 (22.3)
Moderate (score 16–21)	156 (43.0)	Very high (score 30–50)	14 (3.9)

0.402, 95%CI: 0.180–0.898, and p = 0.026). This result suggests that after considering other variables, those who felt better before the pandemic were 2.5 times more likely to rate themselves as happier than average person compared to those who felt the same/did not know their feeling before the COVID-19 pandemic.

DISCUSSION

This cross-sectional study provides unique understandings of the impact the first 5–7 months of the COVID-19 pandemic has had on psychological distress and happiness amongst MSM and transgender people living in Bali, Indonesia. At the time of data collection no peer-review publications had reported findings describing psychological distress or happiness amongst the Balinese MSM or transgender community. A recent study amongst university students in Indonesia found 72% of reported mild depression (24) and a study within the general population reported people under 50 years experienced higher anxiety during the COVID-19 pandemic compared to older participants (25). Another study found 48% of Indonesian women experienced psychological distress as an impact of working from home (26). However, none of these studies employed the K10 to measure psychological distress.

Globally studies across various population groups have employed a range of measures to determine psychological distress (6, 23, 27–32). Studies outside Indonesia conducted during the COVID-19 pandemic have reported the levels of psychological distress using the K10 to be similar to this study (23, 27, 31, 32). An Australian study found 62.5% of adults reported moderate to very high psychological distress (23). Studies conducted in Jordan found nearly 70% of university

TABLE 3 | Factor associated with psychological distress among the study population (based on K10 score).

Characteristics/variables	Low (score 10–15), n (%)	Moderate to very high (score 16–50), n (%)	Univariate analyses			Multivariate analyses		
			P	OR	95%Cls	p	AOR	95% Cls
Total study participants (n = 363)	112 (30.9)	251 (69.1)						
Gender								
Male	87 (33.1)	176 (66.9)		1			1	
Transgender/waria	25 (25)	75 (75)	0.138	1.483	0.881–2.495	0.435	0.725	0.324–1.623
Age								
18–25	19 (30.2)	44 (69.8)		1			1	
26–40	74 (29.8)	174 (70.2)	0.960	1.015	0.556–1.855	0.872	1.064	0.500–2.266
41–60	19 (36.5)	33 (63.5)	0.470	0.750	0.344–1.636	0.962	0.976	0.360–2.650
Sexual identity								
Heterosexual	7 (13.0)	47 (87.0)		1			1	
Homosexual	85 (32.8)	174 (67.2)	0.005	0.305	0.132–0.703	0.046	0.409	0.170–0.984
Bisexual	20 (40.0)	30 (60.0)	0.003	0.223	0.084–0.592	0.052	0.355	0.125–1.007
Education level								
No/Elementary school	9 (23.1)	30 (76.9)		1			1	
Junior high school	13 (21.3)	48 (78.7)	0.835	1.108	0.422–2.906	0.845	1.119	0.363–3.443
Senior high school	66 (34.7)	124 (65.3)	0.161	0.564	0.253–1.258	0.340	0.613	0.224–1.675
Diploma/University	24 (32.9)	49 (67.1)	0.281	0.613	0.251–1.493	0.686	0.795	0.262–2.415
Daily activity								
Regular/full time job	72 (35.6)	130 (64.4)		1			1	
School/college	6 (13.0)	40 (87.0)	0.005	3.692	1.494–9.128	0.005	4.009	1.530–10.503
No job/no school	16 (27.6)	42 (72.4)	0.255	1.454	0.764–2.768	0.357	1.383	0.693–2.759
Home duties/others	18 (31.6)	39 (68.4)	0.570	1.200	0.640–2.249	0.668	1.163	0.584–2.317
Marital status								
Single (not married, widow)	81 (30.9)	181 (69.1)		1			1	
Married	12 (40.0)	18 (60.0)	0.314	0.671	0.309–1.459	0.117	0.485	0.196–1.199
Living with a partner	19 (26.8)	52 (73.2)	0.498	1.225	0.681–2.203	0.316	0.709	0.362–1.389
Place of birth								
Bali	53 (35.6)	96 (64.4)		1			1	
Java	39 (29.3)	94 (70.7)	0.265	1.331	0.806–2.198	0.577	1.201	0.632–2.281
Others	20 (24.7)	61 (75.3)	0.092	1.684	0.918–3.087	0.345	1.209	0.691–2.873
Family attitude about sexual identify								
All accept	30 (30.9)	67 (69.1)		1			1	
All/some reject	10 (16.4)	51 (83.6)	0.044	2.284	1.023–5.098	0.246	1.681	0.699–4.047
Family does not know the sexual identity	72 (35.1)	133 (64.9)	0.472	0.827	0.493–1.388	0.399	0.766	0.412–1.423
Residential district								
Urban	92 (29.6)	219 (70.4)		1			1	
Rural	20 (38.5)	32 (61.5)	0.201	0.672	0.365–1.236	0.958	1.022	0.459–2.272
Networking with MSM friends before COVID-19 pandemic								
Yes	60 (29.1)	146 (70.9)		1			1	
No	52 (33.1)	105 (66.9)	0.415	0.830	0.530–1.299	0.464	0.814	0.469–1.412
Networking with MSM friends after COVID-19 pandemic								
Yes	101 (31.6)	219 (68.4)		1			1	
No	11 (25.6)	32 (74.4)	0.427	1.404	0.745	0.865	1.080	0.443–2.636
Number of regular partner								
Does not have any regular partner	34 (34.7)	64 (65.3)		1			1	
1	62 (33.2)	125 (66.8)	0.794	1.071	0.640–1.793	0.945	1.024	0.524–2.001
>1	16 (20.5)	62 (79.5)	0.04	2.059	1.033–4.101	0.345	1.479	0.446–1.406

(Continued)

TABLE 3 | Continued

Characteristics/variables	Low (score 10–15), n (%)	Moderate to very high (score 16–50), n (%)	Univariate analyses			Multivariate analyses		
			P	OR	95%CIs	p	AOR	95% CIs
Stigma								
Lower stigma (score ≤ median)	69 (35.6)	125 (64.4)		1			1	
Higher stigma (score > median)	43 (25.4)	126 (74.6)	0.038	1.617	1.027–2.547	0.014	1.901	1.140–3.170
Discrimination								
Never experienced discrimination	34 (20.9)	122 (61.0)		1			1	
Ever experienced discrimination	78 (39.0)	129 (79.1)	0.000	2.426	1.512–3.892	0.001	2.464	1.464–4.147
Overall feeling/condition before COVID-19 pandemic								
The same/does not know	46 (40.7)	67 (59.3)		1			1	
Felt better	58 (25.7)	168 (74.3)	0.023	1.699	1.074–2.688	0.002	2.404	1.388–4.161
Felt worse	8 (33.3)	16 (66.7)	0.678	1.215	0.484–3.053	0.293	1.753	0.616–4.988
Level of happiness								
Happier than average person	28 (59.6)	19 (40.4)		1			1	
Less happy than average person	84 (26.6)	232 (73.4)	0.000	4.07	2.160–7.671	0.000	3.962	1.980–7.927
HIV status								
HIV+	35 (26.9)	95 (73.1)		1			1	
HIV−	73 (33.5)	145 (66.5)	0.983	0.295	0.295–3.304	0.078	0.602	0.342–1.059
Have never tested for HIV	4 (26.7)	11 (73.3)	0.588	0.722	0.222–2.347	0.664	0.736	0.184–2.937

students reported severe psychological distress (32), whereas, one third of University teachers (31.4%) in the same country reported severe distress levels (31). A study conducted in New Zealand during a COVID-19 lockdown found one-third of participants to report a K10 score above 12 (moderate to severe psychological distress) (27). The differences in psychological distress among people from different countries may be associated with different characteristics of participants and/or varying impact of the pandemic in terms of isolation measures and infection rates. For example, New Zealanders may have felt they were safer in their own country than elsewhere (27). Another study conducted in Italy also found more than half of participants to report no psychological distress (28). Furthermore, a study amongst medical students in Saudi Arabia found 44.5% of participants reported no distress during the COVID-19 pandemic while 12.8% reported severe distress (30).

Interestingly, in this study participants who identified as homosexual reported lower levels of psychological distress compared to their heterosexual identifying peers. This may be a result of social stigma around sexual orientation in Indonesian society. Those who identify as homosexual may have already embraced and accepted their sexual identity. The MSM participants who identified themselves as heterosexual, are likely to have not gone through this process. In Indonesia there is significant social stigma associated with identifying as homosexual or bisexual (12). These participants are likely to be struggling with their sexual identity and many may also be hiding their identity from family or friends or living a double life which may contribute to their higher levels of psychological distress.

This study also found MSM and transgender students were four times more likely to report moderate to very

high psychological distress in comparison to peers currently working full-time. This phenomenon could be due to students experiencing higher levels of stress associated with studying and adapting to new ways of learning (for example, online learning). University students in France reported more than 60% of participants experienced moderate to severe life stress (33), however a study among medical school students in China found <4% reported "at least moderate" levels of anxiety during the COVID-19 pandemic (34). The lower prevalence of distress amongst working group participants may also reflect higher levels of well-being and resilience from having overcome past adversities and experiencing fewer daily disruptions which may help protect subjective happiness (27, 35). Higher levels of resilience has been suggested to reduce fear and anxiety due to COVID-19 (35). These findings warrant further investigation regarding the potential protective factors of employment during COVID-19 on the impact of psychological distress.

Other factors that significantly influenced psychological distress amongst MSM and transgender in this study were stigma and discrimination experiences. Participants who reported high levels of stigma or had ever experienced discrimination were more likely to report higher psychological distress. Stigma and discrimination are associated with poorer social and emotional health, consequently affecting levels of psychological distress (36). The impacts of the COVID-19 pandemic may act as additional stressors on stigma and discrimination. In countries that reported high levels of stigma toward sexual minority groups, lower life satisfaction were experienced by those who did not conceal their status in order to avoid discrimination (37). Furthermore, global evidence demonstrates that COVID-19 pandemic restrictions have been used as an

excuse to discriminate, perpetuate stigma, and violence against LGBT individuals which may also increase distress levels (38). Moreover, LGBT populations, especially those who have other minority identities (such as ethnic minorities) face higher likelihood of unemployment, HIV, suicide and mental health problems, institutional discrimination and other human right violations compared to the general population (39). Analyses of three studies focusing on the health and happiness of LGBT individuals found minimizing discrimination to be positively associated with subjective well-being (40). A study of life satisfaction amongst sexual minority groups in 28 European countries revealed that life satisfaction varied greatly across countries, due to the structural stigma of those countries and was related to the varying demands that were required to conceal an individual's sexual orientation (37). These findings warrant further investigation regarding the role of factors related to stigma and discrimination on the mental health of LGBT communities during the COVID-19 pandemic.

Participants in this study who felt their overall feeling was better before the pandemic were 2.4 times more likely to report moderate to very high psychological distress compared to participants whose felt they had the same feeling before the pandemic. Similarly, longitudinal research in the United States (US) identified significant increases in distress during the emergence of the COVID-19 pandemic (41). However, the levels of distress were largely diminished in the weeks that followed, which might be associated with increased resilience (41). Furthermore, a national survey in Ireland revealed significant increases in symptoms of depression, stress, and anxiety upon entry into COVID-19 quarantine (42). Different levels of psychological distress across populations, including patients who experienced COVID-19 infection; individuals under quarantine; and the general population were reported in China (43). The prevalence of depression (29.2%) increased predominately in patients who experienced COVID-19 infection (43), while COVID-19 patients and the general public reported a greater proportion of severe depressive symptoms compared to those in quarantine (43).

The majority of MSM and transgender participants in this study viewed themselves as less happy than the average person, which may be due to fear of COVID-19. A study examining the relationship between hope, resilience, and subjective happiness in Turkey revealed that subjective happiness was mediated by a fear of COVID-19 (35). However, this study was unable to compare the subjective happiness level before and after COVID-19. Compared to 2016, the proportion of unhappiness in the general population in China doubled during the COVID-19 pandemic (44). To date, no peer-review publications appear to have reported happiness amongst MSM and transgender communities during the COVID-19 pandemic. However, a US study revealed that the majority of MSM participants had decreased quality of life and increased anxiety due to COVID-19 which was similar to the findings of this study (45).

Comparable to the psychological distress findings, when happiness was considered, none of the heterosexual participants reported to be happier than average person. Participants who were currently living with a partner were 19 times more likely

TABLE 4 | Level of happiness among the study participants ($n = 363$).

Subjective Happiness Scale (SHS) individual items	Mean (SD)	Range
In general, I feel myself	5.17 (1.39)	6
When compared to most of my friends, I feel that I	5.11 (1.49)	6
Some people are generally very happy. They enjoy life no matter what happens, get the most out of everything. To what extent do these categories suit you?	4.98 (1.37)	6
Some people are generally not very happy. Even though they are not depressed/sad, they don't look as happy as they should. To what extent do these categories suit you?	4.31 (1.63)	6
SHS total (reverse the 4th question)	18.96 (3.53)	18
SHS score (reverse the 4th question)	4.74 (0.88)	4.5
Level of happiness ($n = 363$)	**n (%)**	
Less happy than average person	316 (87.1)	
Happier than average person	47 (12.9)	

to rate themselves as less happy than average person compared to those who were currently living alone. A nationally representative study in the US revealed that stress related to sexual minority status in earlier life may accumulate over time, resulting in lower happiness later in life (46). Moreover, those with current different-sex partners but histories of same or both-sex partners may be disadvantaged and the heterosexual identified group may also have faced pressure to act "closeted" and may be unhappy with their current sexual arrangements (47, 48). Furthermore, current and lifetime measures of the sex of sexual partners revealed important happiness differences, which advised that stability in sex of sexual partners was associated with better well-being/happiness (48).

Psychological distress and level of happiness were highly associated. In this study, those who reported moderate to very high psychological distress were four times more likely to be less happy compared to those who reported low psychological distress. Likewise, compared to happier people, those who were less happy were also four times more likely to report moderate to very high psychological distress. A study in Turkey found distress and happiness to have a negative correlation (inversely correlated) and positivity to be a potential mediator on COVID-19 perceived risk, death distress, and happiness (49). Individual's positive views about self, life and future (positivity) was positively associated with happiness and negatively associated with death distress (49). Therefore, it has been suggested positivity is an important aspect of developing strength-based programs aiming to lessen psychological distress and increase happiness (49).

Study Strengths and Limitations

This study provides baseline findings about psychological distress and happiness amongst specific marginalized populations in Bali, Indonesia. The study achieved a sufficient sample during a crisis period (14). However, the study is subject to a number

TABLE 5 | Factor associated with level of happiness among the study population (based on SHS score).

Characteristics /variables	Happier than average person	Less happy than average person	Univariate analyses			Multivariate analyses		
			P	OR	95%Cls	*p*	AOR	95% Cls
Total study participants (*n* = 363)	47 (12.9)	316 (87.1)						
Gender								
Male	33 (12.5)	230 (87.5)		1			1	
Transgender/waria	14 (14.0)	86 (86.0)	0.713	0.881	0.450–1.727	0.251	1.969	0.619–6.265
Age								
18–25	7 (11.1)	56 (88.9)		1			1	
26–40	23 (13.3)	215 (86.7)	0.643	0.814	0.342–1.938	0.601	1.354	0.435–4.213
41–60	7 (13.5)	45 (86.5)	0.702	0.804	0.263–2.460	0.456	1.763	0.397–7.827
Sexual identity								
Heterosexual	0 (0.0)	54 (100.0)		1			1	
Homosexual	40 (15.4)	219 (84.6)	0.997	0.000	0.000	0.997	0.000	0.000
Bisexual	7 (14.0)	43 (86.0)	0.997	0.000	0.000	0.997	0.000	0.000
Education level								
No/Elementary school	7 (17.9)	32 (82.1)		1			1	
Junior high school	9 (14.8)	52 (85.2)	0.671	1.264	0.429–3.727	1.000	1.000	0.284–3.518
Senior high school	22 (11.6)	168 (88.4)	0.280	1.670	0.659–4.237	0.066	2.804	0.934–8.414
Diploma/University	9 (12.3)	64 (87.7)	0.421	1.556	0.531–4.558	0.400	1.723	0.486–6.106
Daily activity								
Regular/full time job	32 (15.8)	170 (84.2)		1			1	
School/college	1 (2.2)	45 (97.8)	0.038	8.471	1.127–63.681	0.232	3.715	0.432–31.965
No job/no school	7 (12.1)	51 (87.9)	0.480	1.371	0.571–3.292	0.754	0.846	0.297–2.412
Home duties/others	7 (12.3)	50 (87.7)	0.508	1.345	0.560–3.230	0.941	1.043	0.347–3.135
Marital status								
Single (not married, widow)	43 (16.4)	219 (83.6)		1			1	
Married	3 (10.0)	27 (90.0)	0.367	1.767	0.513–6.087	0.418	1.850	0.418–8.196
Living with a partner	1 (1.4)	70 (98.6)	0.010	13.744	1.859–101.639	0.005	19.463	2.474–153.124
Place of birth								
Bali	16 (10.7)	133 (89.3)		1			1	
Java	23 (17.3)	110 (82.7)	0.114	0.575	0.290–1.143	0.103	0.485	0.203–1.157
Others	8 (9.9)	73 (90.1)	0.838	1.098	0.448–2.688	0.699	0.816	0.291–2.289
Family attitude about sexual identify								
All accept	30 (30.9)	67 (69.1)		1			1	
All/some reject	10 (16.4)	51 (83.6)	0.142	2.212	0.766–6.388	0.378	1.767	0.498–6.269
Family does not know the sexual identity	72 (35.1)	133 (64.9)	0.373	1.360	0.692–2.673	0.156	2.139	0.748–6.113
Residential district								
Urban	42 (13.5)	269 (86.5)		1			1	
Rural	5 (9.6)	47 (90.4)	0.442	1.468	0.552–3.901	0.890	1.095	0.303–3.950
Networking with MSM friends before COVID-19 pandemic								
Yes	24 (11.7)	182 (88.3)		1			1	
No	23 (14.6)	134 (85.4)	0.400	0.768	0.416–1.419	0.445	0.716	0.304–1.687
Networking with MSM friends after COVID-19 pandemic								
Yes	45 (14.1)	275 (85.9)		1			1	
No	2 (4.7)	41 (95.3)	0.103	3.355	0.784–14.356	0.124	3.357	0.717–15.711
Number of regular partner								
Does not have any regular partner	18 (18.4)	80 (81.6)		1			1	
1	25 (13.4)	162 (86.6)	0.265	1.458	0.752–2.828	0.826	0.918	0.431–1.959
>1	5 (5.1)	74 (94.9)	0.013	4.162	1.347–12.867	0.071	3.034	0.911–10.103

(Continued)

TABLE 5 | Continued

Characteristics /variables	Happier than average person	Less happy than average person	Univariate analyses			Multivariate analyses		
			P	OR	95%CIs	*p*	AOR	95% CIs
Stigma								
Lower stigma (score ≤ median)	23 (11.9)	171 (88.1)		1			1	
Higher stigma (score > median)	24 (14.2)	145 (85.8)	0.507	0.813	0.440–1.500	0.234	0.649	0.318–1.324
Discrimination								
Never experienced discrimination	26 (13.0)	174 (87.1)		1			1	
Ever experienced discrimination	21 (12.9)	142 (87.1)	0.974	1.010	0.546–1.871	0.416	0.705	0.304–1.635
Overall feeling/condition before COVID-19 pandemic								
The same/does not know	12 (10.6)	101 (89.4)		1			1	
Felt better	31 (13.7)	195 (86.3)	0.420	0.747	0.368–1.518	0.026	0.402	0.180–0.898
Felt worse	4 (16.7)	20 (83.3)	0.406	0.594	0.174–2.031	0.238	0.444	0.115–1.712
Psychological distress (K10)								
Low	28 (25.0)	84 (75.0)		1			1	
Moderate to very high	19 (7.6)	232 (92.4)	0.000	4.070	2.160–7.671	0.000	4.525	2.210–9.265
HIV status								
HIV+	17 (13.1)	113 (86.9)		1			1	
HIV−	28 (12.8)	190 (87.2)	0.950	1.021	0.535–1.948	0.814	1.103	0.489–2.486
Have never tested for HIV	2 (13.3)	13 (86.7)	0.978	0.978	0.203–4.717	0.297	2.952	0.385–22.612

of limitations. Participants predominantly resided in urban areas (the capital city of Bali). Considering the restriction of movement and social distancing during the COVID-19 pandemic, findings might be more generalizable to Indonesian urban, compared to rural areas. The experiences of MSM and transgender people living in Bali, may differ in other areas in Indonesia. Findings of this study were limited to MSM and transgender who have accessed sexual health clinics or an NGO outreach service in Bali; hence, the study may not be generalizable to those who live in remote areas those not currently connected to a health service and/or those who may have more limited access due to COVID-19 restriction (50). The survey, which began development before the pandemic, asked limited questions specific to the COVID-19 pandemic. The study was unable to assess the effect of the COVID-19 pandemic on mental health and happiness of MSM and transgender in Bali since the baseline data were not available. Further research is warranted to provide a deeper understanding of the impact of COVID-19 on MSM and transgender people in Bali, Indonesia.

Policy Implication and Future Research

This study provides an important insight into to the mental health and happiness of sexual minority groups which are sometimes neglected and highly at-risk (51). Mental health and consequently access to mental health services are stigmatized in some countries like Indonesia, and the COVID-19 pandemic makes access more difficult due to isolation measures. The findings of this study suggest that psychological distress amongst MSM and transgender people is a significant public health issue which is influenced by many factors. The psychological impact of COVID-19 may also exacerbate mental health burden

and vulnerability among these already at risk communities (e.g., anxiety, depression, and suicidal thoughts) (52). Given stigma and discrimination have been found to significantly influence psychological distress, population based interventions are necessary to effect social and policy changes. Concurrently access to mental health support service for these populations is critical during and after the pandemic (51, 52). Happiness is certainly a variable that influences psychological distress in these communities. Future research will need to explore various solutions to mitigate the exacerbation of the mental health burden due to the COVID-19 pandemic amongst MSM and transgender communities This may include targeted online and telehealth services and/or 24/7 helplines which can be accessed regardless of restrictions. Further investigation around the potential protective factors of employment during COVID-19 on the impact of psychological distress and happiness is also needed to inform policy and practice.

CONCLUSION

MSM and transgender individuals currently living in Bali, Indonesia are facing moderate to very high psychological distress and lack of happiness during the COVID-19 pandemic. Several factors contributed to the distress including being a student, reporting higher levels of stigma, had ever experienced discrimination, felt themselves better before the COVID-19 pandemic, and reporting less happy than average person. Factors contributed to reduced happiness including living with a partner and having moderate to very high psychological distress. These findings provide early evidence of the need for interventions aimed at improving general mental and sexual health amongst

these communities during and after the pandemic. Stigma and discrimination are important areas of focus to reduce distress. Whilst these are not new issues for MSM and transgender communities, the COVID-19 pandemic is likely to exacerbate the impact. MSM and transgender people in Indonesia may become more hidden and find it difficult to access necessary sexual health services. Furthermore, restrictions may have further exacerbated the level of distress amongst those who are studying. Further research to explore the development of public health policy and the efficacy of interventions, particularly those that can be implemented through the NGO research partners, to support MSM and transgender people in Bali is required. This may include increased access to services including provision of online or "remote" services for MSM and transgender people. Broader governmental strategies to address employment during the pandemic should also be considered.

DATA AVAILABILITY STATEMENT

The supporting data of this study are available on request from the corresponding author. Access data set requests should be directed to Ni Wayan Septarini, septarini@unud.ac.id.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Human Ethics Committees, Faculty of

Medicine, Udayana University/Sanglah Hospital, Bali, Indonesia (No: 2521/UN14.2.2.VII.14/LP/2019) and Curtin University, Western Australia (HRE 2019-0759). The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

NS developed and drafting the proposal, data collection, analyses, and preparing/drafting the manuscript. JH, SB, and BM contributed equally to the acquisition and interpretation of data, revision on results, and critically reviewed the manuscript. All authors contributed to the article and approved the submitted version.

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Social Quarantine and Its Four Modes: Conceptional Exploration and the Theoretical Construction of the Policies Against COVID-19

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Building on the studies of health quarantine from a social perspective, this article explores the complex contexts of social quarantine as a mode of public health, a mode of community action and a behavioural and psychological mode of social distancing. To establish a conceptual investigation of the "social quarantine" issue, this study investigates four approaches to quarantine: public health, social administration, behavioural norms, and psychological effects. The study identifies the features of these modes and discusses their relationships. In addition, this study constructs a preventive framework for quarantine that embraces social and health policies to enrich the understanding of policy measures for social distancing and lockdown measures. On this basis, the study evaluates the strategies of policy development in response to the COVID-19 pandemic. The study concludes that these modes can reconstruct social relations and provide some basis for theoretical analysis about the features of social quarantine, which is vital for policymakers when considering national and global prevention strategies for public health.

Keywords: quarantine, social quarantine, social contact, COVID-19, global health, social policy, community, pandemic

INTRODUCTION

The COVID-19 pandemic declared in early 2020 has stimulated academic discussions about the idea of social quarantine. With different quarantine measures adopted globally, the debate on the social effects of mandatory quarantines and widespread travel restrictions has become popular. Some regard them as doing more harm than good (1), whereas others insist they are positive measures to prevent illness. For instance, Specktor (2) commented on large-scale quarantine strategies implemented in countries such as China, Italy, and India, and their blunting the curve of COVID-19 infections in these countries, and Tognotti (3) stated that the quarantine strategy raises ethical, political, and socioeconomic problems, and that a balance is required between individual rights and the public good. These debates have impacted research conditions regarding social quarantine as a means of public health, and as an important tool used to control unexpected illnesses or to prevent epidemics.

In the global context, the World Health Organization (4) defined "quarantine" as "the restriction of activities of healthy persons who have been exposed to a communicable disease, during its period of communicability, to prevent transmission during the incubation period if infection should occur." This quarantine ideal, as a non-pharmacological general well-being framework

of policy analysis, became popular during the pandemic as a mean to curb the spread of the virus (5), especially when knowledge about the virus and its features was limited. However, the public views the need to apply social quarantine not only as a health measure, but also for social control and social administration. Brooks et al. (6) stressed that quarantine can lead to stereotypes and prejudices about certain people based on their appearance, race, culture, or national origin regardless of scientific facts; Drews (7) also regards quarantine within the parameters of human technology to provide a deeper understanding of its uses in relation to advancements made in science and medicine.

Accordingly, we need to do conceptual and theoretical work on various meanings of social quarantine and to assess its social consequences from different aspects. People apply social quarantine mechanisms to reduce social communication through two distinct strategies: mitigation and suppression (8). The former aims to reduce the infection rate through non-pharmaceutical interventions, whereas the latter takes extremely limiting measures to reduce the number of new cases. At the behavioural level, a study conducted in Italy states that when the most stringent community quarantine measures are employed, this reduces all activities in the community. It is more than evident that reduced community activity influences behavioural norms, group or household sizes, and generates feelings of social exclusion.

This study will address the variables affected by COVID-19 during social quarantine and discuss the usage and outcomes of implementing social quarantine modes. The study will adopt both macro- and micro-level analyses to interpret the ideal of social quarantine. From a macro-level perspective, the need of social quarantine should be managed to achieve a balance between the interests of public health and the emergency of economic operation. In the context of community actions and socioeconomic development, this ideal should be assessed within both normative and structural reasons, since quarantine concerns both social and economic functions. Thus, the study will evaluate the policy implications of community shutdowns and regulating people's daily lives to achieve economic reopening in response to the COVID-19 pandemic.

From a micro-level perspective, Kissler et al. (9) insisted that compulsory home quarantine and the arrangement of isolation can effectively alleviate the spread of infection, together with policy measures, including school and business closures (8, 10, 11). As argued in some policy studies, the large-scale quarantine measures at the time of the 2003 SARS epidemic were conceptualised in light of social distancing (12). Meanwhile, the quarantine issue should also be analysed at the behavioural level. Indeed, social quarantine actions must consider the psychological function of individuals and thus involved the issues of public opinion, mass reaction, and social psychology, along with their social movement and political activities.

Nevertheless, having discussed the behavioural and psychological aspects, this study mainly engages conceptual work and policy analysis on the subject rather than sociological studies of structural interpretations of the rules and behaviours of quarantine. In previous studies, some researchers showed the effect of prolonged quarantine was associated with poor mental health, particularly post-traumatic stress symptoms, anger, and avoidance behaviour (6, 13, 14), and at the behavioural level, the regulations about the behavioural rules are discussed, such as a distance of one metre between customers in bars and coffee shops and the rules reducing interpersonal interactions in social meeting. Thus, this study constructs a four-modes frame of analysis and test explanatory power of these modes in the policy practises as the strategy of prevention in the COVID-19 pandemic.

REVIEWING THE STUDIES ON SOCIAL QUARANTINE

Despite many studies about social quarantine measures impacting the health function of epidemic prevention, the social contexts and consequences of quarantine has not been examined thoroughly. Thus, how to evaluate the success or failure of local practises, and from what perspectives become the key issues of our analysis. The implementation of quarantine strategies should be assessed in consideration of local sociocultural contexts, not simply in the terms of health technology and caring standards. Thus, Blendon et al. (15) talked about the experience of preventing the SARS outbreak, praising mainland China, Hong Kong, Singapore, and Taiwan as successes, whereas Schabas mentioned that the mass quarantine strategy was a failure in Toronto (16). In the case of COVID-19, China again achieved remarkable results in controlling its spread by implementing strict quarantine strategies; however, some observers asserted this success could only happen in China because a similar technique was hardly used in other countries, such as the United States, India, and Pakistan (17, 18).

In the study of social consequence on a macro-level, some scholars expose the social impact of quarantine on the issue of social exclusion. Moisio (19) pointed out that social quarantine may aggravate social inequalities and class disparities since the most vulnerable groups during the pandemic were those low- and middle-income families as these groups were severely affected by market closures and months of factory lockdowns. The use of quarantine to isolate people raises the risk of social exclusion and, at the same time, often violates the freedom of outwardly healthy people, particularly people from marginalised groups who are stigmatised and discriminated against (3). In this regard, the COVID-19 crisis must have a devastating effect on vulnerable population by potential exacerbating existing unequal access to education, healthcare, and social services.

The most crucial issue in this quarantine debate is the social consequence of restricting individual mobility against individual freedom. Bensimon and Upshur (12) emphasised that the effectiveness of public health interventions should not be defined only in (absolute and objective) scientific terms but should also be conceptualised reasonably and normatively in public health decision-making. For these policy studies and evaluations, Sopory el al. (20) pointed out that often the effectiveness of quarantine is judged by some utilitarian criteria of reducing mortality and morbidity, and suggested that discussion

should also include additional criteria. The protection of civil rights and protection from harm, as quarantine may impose on people without their consent. Thus, some researchers criticise the enforced use of social quarantine in the face of a dramatic health crisis because individual rights have often been trampled in the name of the public good (12, 16, 21).

Though the aforementioned studies focused on the macro-level effects of social quarantine, we should not ignore its effect at the micro-level. In previous studies, some researchers reported the harmful impacts of quarantine on mental health; for example, according to Brooks et al. (6), people under quarantine experienced negative mental health impacts, including post-traumatic stress disorder, anger, and confusion, Marjanovic et al. (22) talked about healthcare workers who were quarantined engaging in avoidance behaviours, such as minimising direct contact with patients and not reporting to work. In this regard, Tang et al. (1) reported the depression and anxiety in a group that underwent quarantine was higher than the group that did not undergo quarantine, and Caleo et al. (23) showed that the main stressors for COVID-19-infected individuals/those suspected of having the virus post-quarantine are financial issues and stigma from society. Therefore, we should consider the psychological and individual aspects of social quarantine as well.

Since the function of social quarantine can be interpreted from different angles and approaches, our analysis should look at both the macro- and micro-levels of social actions to develop the conceptual and theoretical work to respond many complicated issues to be engaged. Research shows that individuals cope better with changes in lifestyle when they plan for said changes; this has also been shown to enable better compliance with public health guidance. With regard to the policy analysis, moreover, social quarantine measures are key to discussing virus prevention and rehabilitation to solve policy decisions in addressing the conflict between both scenarios. This framework points to the importance of justifying public health intervention on the basis of its effectiveness.

RESEARCH DESIGN ABOUT A FOUR-MODES FRAME OF ANALYSIS

To classify social quarantine in various contexts, we propose four basic analytic modes. First social quarantine should be referred to as a mode of public health. In the original sense, social quarantine is an exhaustive tool used to control unexpected illnesses to prevent epidemics. In Gordon's (24) terms, "quarantine" is used to contain those who are asymptomatic but not resistant to infection. This method was first used during the Black Death in the fourteenth–fifteenth centuries in the Southern and Eastern Europe (25), when a 40-day quarantine period was applied to high-risk groups. Thus, from a health perspective, social quarantine can ensure that infected individuals are distant from the general population to reduce the frequency of interpersonal communications. Hence, "quarantine" refers to the policy restricting people's movements (26), and to be effective, social quarantine as a mode of public health requires a number of health policies to prevent uncontrollable sources, hinder the

transmission process, and ensure the safety of the susceptible population (27).

Social quarantine can also be a mode of community action. This makes the community service an essential element of social segregation by separating people or communities who have been exposed to an infectious disease. Therefore, community lockdowns, checkpoints, suspension of open markets, and border controls have all been used to curb the spread of COVID-19. These actions involve the interaction and collaboration of various local stakeholders, including actual and potential patients, volunteers, and local administrators. Social distancing measures to target the spread of viruses among the population may, at the community level, include the closure of schools and organisations, mandatory travel restrictions, curfews, and limitations to the sizes of parties (28). Additionally, community services maintain social distancing by isolating sick residents and keeping them under observation. A pre-existing favourable environment for health and hygiene practises makes operating or even increasing quarantine measures in a community easier for community organisations ((29–31)).

The implementation of social segregation requires the cooperation of residents, since in the quarantine actions, people participate in multifaceted and complex activities with their family, social networks, and organisations by engaging in community activities and individual behaviour (32). Thus, the adoption of community education is essential for local governments to establish an epidemic warning system to reduce people's possibly risky behaviour in social activities. In some instances, all residents of high-risk areas were encouraged to stay at home, an effective way to protect the community from exposure to infection. Thus, positive neighbourhood relationships and access to information about the disease are important for the local control of health conditions. It has also been stated that the use of quarantine to isolate people suspected of being infected—often violating the freedom of outwardly healthy people, especially people from lower classes, minorities, and marginalised groups—leads to stigmatisation and discrimination (3). Taking the time to engage community members, inform them, and to act as an effective liaison between them and district health authorities through trusted local leaders, helps implement effective segregation at a community level.

Social quarantine can also be a mode of individual behaviour. An ideal "social quarantine" demands that every member of local society should voluntarily apply social distancing. If people do not comply, the social quarantine model will not be effective. For example, wearing masks in public places should be encouraged, and elbows should be touched in greeting instead of hugging, kissing or shaking hands to reduce the frequency of interpersonal communication ((33); Smith et al., 2017). Hand washing and avoidance of crowds may be measures applied to maintain distance from interpersonal connexions. Thus, some restrictive measures should be taken to control individual behaviour, and all misconduct and improper behaviours that carry the risk of infection should be penalised to restrict people's behaviour. These requirements change the behavioural models of people's daily lives.

When the behavioural mode is implemented, social quarantine will inevitably be affected by the moral and cultural characteristics of the local society. From the perspective of "rationality," people's behaviour is determined by social norms, the perceived benefits of quarantine, the risks of disease and the effectiveness of quarantine. Once people know about the risk of a certain disease, they formulate new rules affecting behavioural changes. Discussions on behavioural patterns must refer to the social norms and cultural background of individual behaviours. Thus, the behaviour of social quarantine will be influenced by the cultural qualities of the local society. For instance, mandatory prohibitions against praying in a church during quarantine compromised the religious lifestyle and increased the anxiety of religious individuals (34). Thus, we need to express the relationship between social isolation as a code of conduct and local morality and should formulate separate agreements according to different cultural contexts.

Lacking access to the outside world, patients may feel discomfort and a perception of risk (35), and may fear that threats may be evident (Cole, 2013). In this case, social isolation can be a mental mode comprising several sensations and feelings. Thus, a psychological mode of social quarantine also exists, as a pandemic will produce certain subjective feelings, such as danger and panic (specifically when in crowds). The vulnerability of emotional elasticity is the most evident feature of the psychological mode of social isolation. Social distancing may exacerbate loneliness and negatively affect health in the long run, as research showed that quarantine can also contribute to stress and anger (36, 37). In particular, when information and communication are insufficient, people's feelings are heightened, and they may be over sensitive to the risks to themselves or others.

Therefore, social isolation can have a negative effect on the psychological characteristics of individual behaviour. The pandemic caused a high prevalence of stigmatisation in public groups, followed by traumatic stress symptoms and insomnia, anxiety, and depressive symptoms. Thus, social segregation should be studied from a psychological perspective, together with psychiatric symptoms, mental disorders, and mental health problems, which may lead to biological and psychological abuse. As reported, quarantine measures cause up to four times as much post-traumatic stress in isolated people compared to non-isolated people (6). It can also lead to legal wrangling, messy confrontations, and poor mental health. Researchers found long quarantine periods can cause symptoms of post-traumatic stress disorder and depression in patients. People in quarantine often experience anxiety, frustration, or fear of infection, as well as negative feelings related to isolation, loneliness, anger, and perceived or actual stigma (38–41). Thus, the quarantine will greatly affect people's attitudes towards discipline, collective action, and social grouping (42).

In the case of COVID-19, the rapidly increasing numbers of disease outbreaks worldwide often caused anger and anxiety in different nations. Fear and perceived threats of socioeconomic groups may lead to intolerance and punitive attitudes towards outsiders (43, 44). The experience of fear and threat not only affects people's perception of themselves, but also influences their perception of and reaction to others—in particular, out-groups. Indeed, in the 2020s, fear during the pandemic, together with the economic difficulties associated with the increase in the prevalence of cases, drove risks usually associated with high levels of ethnocentrism. This mass psychology poses a great risk to international relations and may lead to optimism bias inducing excessive feelings of anxiety, as it influences international affairs with a hasty attitude and leads to disputes for irrational reasons.

POLICY IMPLICATIONS OF IDENTIFYING FOUR SOCIAL QUARANTINE MODES

The four aspects of social quarantine listed above—clinical, communal, behavioural, and psychological—help us to assess the situation of anti-pandemic interventions in different contexts. This four-mode interpretation improves our understanding of the function of social quarantine and its features. We need to study the policy implication of these modes in various aspects. In defining these four modes from macro- and micro-level viewpoints. The clinical and community models refer to macro-level social approaches for epidemic control, whereas behavioural and psychological models refer to micro-level individual perspectives. From a macro-level standpoint, the COVID-19 pandemic is not only a public health crisis but also a socioeconomic emergency. This crisis led to a risk to public health, as the virus has spread globally. It poses a risk to states and may require an organised international response.

To meet the needs of social quarantine in a clinical mode, we may adopt policy measures to reduce the risk of transmitting viruses through human contact. These policy measures include smart health through long-distance diagnoses, through which doctors can advise their patients. The monitoring system, the service platform, and the home-based quarantine facilities work effectively for prevention, and moving school courses from classrooms to online platforms is also quarantine in the clinical sense. Meanwhile, a tracing system (as in China's system of green code) greatly contributes to preventing disease transmission, and the hospital grading system also helps avoid crowding of patients in hospitals, thus reducing the risk of mutual infection.

The policy measures for social quarantine in the mode of community actions include community lockdown, traffic suspension, and the ban of gathering at bars and commercial centres. Voluntary services for checkpoint monitoring in the community involves using volunteers to provide a full range of services for those under community quarantine conditions, including door-to-door delivery, control of community mobility, and decentralisation of social gatherings (45). These policy actions demonstrate the significance of "community-wide containment" to reduce infection rates at different stages of the disease (46–49). "Isolation is the separation, for the period of communicability, of known infected persons in such places and under such conditions as to prevent or limit the transmission of the infectious agent" (4).

In light of the behavioural models, social interaction is deeply rooted in human interaction and social organisation, and social quarantine refers to social distancing that reduces human

interactions. In this regard, there are policies to regulate normal behaviour in a pandemic, such as keeping a distance of one metre between customers and wearing masks in shopping centres. The production of guidelines for people to reshape their behavioural model ultimately changes people's minds, thereby affecting their levels of mental health. Once social distancing becomes a norm in people's daily behaviours, they become more active in supporting the clinical mode and the community model of social quarantine, integrating the rules into their behaviour, and affecting the pace of rehabilitation.

Concerning the psychological mode, policies were created to relieve symptoms, such as trauma and anxiety in the victims of the pandemic. Loneliness and social isolation increase the burden of stress, and often have detrimental effects on psychological health, cardiovascular health, and the immune system (50). Some reports from Nigerian households in quarantine due to Middle East respiratory syndrome (MERS) show anxiety, depression, mental distress, and the influence of grief-related trauma during MERS (51, 52). Similar reports related to COVID-19 cases describe public fear, anxiety, exhaustion, and detachment from others; with feelings of uncertainty and unpredictability. Thus, policies for psychological welfare require information transparency and mass media messaging to address mass trauma and to provide comfort and entertainment for the people in quarantine at home.

Despite these four modes being identified as different, we can also perceive them as being interrelated. The technological instrument facilitates the models of clinical and community modes, which influences people's antivirus actions. The behavioural model is influenced by the rules of social quarantine imposed on human communication and affects the norms of daily life. Since quarantine practise can allow people a sense of uncertainty while limiting their movement among communities, the behaviour model influences mental health by warning of infection, which has an effect on the social quarantine of normal people. In the long run, these psychological effects are moderated with community service. Thus, the clinical need for social isolation has diminished, and community barriers have been removed through policy work on behaviour and psychological models.

Meanwhile, different societies have different policy strengths, which are also affected by their social-cultural contexts. Social distancing rules were still useful, particularly when there was no vaccine available. Alongside some common practises, such as wearing masks and changing our patterns of interpersonal connexion, we need to study the special features of their policies against the pandemic, and the four-mode framework is a practical basis for this comparative analysis. In previous studies, social quarantining has been regarded mainly as a tool to control the prevalence of a disease, and thus the clinical and public health functions are highlighted when assessing social quarantine, but social and behavioural functions are less so. Meanwhile, social quarantine has a very strong function of social administration, so there are overlapping needs of medical and social administrative functions (53). This could create some debate and cause controversy in academic and policy-making circles.

EXAMPLES OF SOCIAL QUARANTINE IN CASE COMPARISONS

Overall, the four-dimensional approach to social quarantine explains why returning to normal life and a normal economy is difficult due to the complicated impacts of social quarantine. Of the four modes, social quarantine must be understood in different ways. Different countries may have mutual learning practises for social quarantine strategies, and different community intervention strategies must be selected, calibrated, and implemented according to the intensity of local COVID-19 transmission to avoid the risk of spreading the virus (54). With this understanding, we can observe how different countries use social quarantine policies to respond to crises in different ways. Thus, in this section we select three cases of illustration for these modes to reveal the policy implication of these modes and their influence over the strategies on the local practises against the Covid-19. The diversity of these approaches leads us to consider the policies' contexts and different socio-political environments.

The German Experience of the Clinical Mode

In Europe, Germany ranked first in terms of per capita gross domestic product. In this pandemic, its number of reported cases is twelve among the top 10 European economies (see **Table 1**), and its mortality rate is not very high (nearly 11% of infections). This performance rests on its numerous healthcare policies. In addition, people have high confidence in the developed healthcare facilities to fight the virus, as Germany is among the top five countries in the European Union that have a high number of nurses (13.2) and doctors (4.2) per 1,000 people (55). It also prepared a strong private and public laboratory sector, with nearly 200 laboratories having COVID-19 testing capacity and ventilators. More importantly, Germany's system for grading clinical diagnoses prevented patients from congregating in large hospitals (56), with only those with suspected symptoms hospitalised.

Meanwhile, Germany was the first place to successfully use a smart health system to implement a strategy for social quarantine. As this smart health system operated successfully in Germany, the flow of medical services to large hospitals was reduced. This promotes the idea of social distancing by avoiding crowds in hospitals. In addition, Germany demonstrated the importance of the clinical mode of social quarantine through its advanced family doctor system. In this system, general practitioners facilitated a system of distanced health services, and the contracts signed between family doctors and the local community have been widely recognised. People can contact their family doctors for consultations, diagnoses, and treatment without needing to visit hospitals.

The Chinese Experience of Community Mode

A clinical mode of social quarantine was used in the initial phase in China by building two new hospitals (Huoshenshan and Leishenshan in Wuhan) and 14 temporary healthcare

Country/economy	GDP (PPP)		Covid-19					
	Share in 2019 % Europe (Eur.)	Rank	Cases		Deaths		Population Per 100,000	
			Total	Rank	Total	Rank	Cases	Deaths
Germany	17.4	1	3,722,782	12	90,472	11	4,476	109
United Kingdom	12.3	2	4,640,511	7	127,981	7	6,836	189
France	12.2	3	5,650,315	4	109,879	9	8,688	169
Italy	8.94	4	4,253,460	9	127,291	8	7,132	213
Russia	7.36	5	5,350,919	6	130,347	6	3,667	89
Spain	6.28	6	3,764,651	11	80,689	14	7,954	170
Netherlands	4.06	7	1,679,542	20	17,727	30	9,648	102
Turkey	3.34	8	5,375,593	5	49,236	19	6,374	58
Switzerland	3.22	9	698,872	38	10,270	43	8,075	119
Poland	2.54	10	2,879,030	14	74,858	15	7,585	197
Sweden	2.38	11	1,084,636	26	14,574	35	10,502	141
Belgium	2.33	12	1,079,640	28	25,141	25	9,370	218
Austria	2.01	13	645,609	39	10,419	42	7,253	117
Norway	1.88	14	129,545	93	790	116	2,413	15
Ireland	1.73	15	269,321	68	4,941	63	5,425	100
Denmark	1.56	16	291,801	63	2,531	83	5,011	43
Finland	1.21	17	94,379	102	967	108	1,708	18
Czech Republic	1.11	18	1,666,192	21	30,283	22	15,581	283
Romania	1.1	19	1,080,323	27	32,465	20	5,589	168
Portugal	1.06	20	865,806	30	17,068	31	8,409	166
Greece	0.962	21	418,548	49	12,565	39	3,905	117
Hungary	0.766	22	807,684	33	29,879	23	8,267	306
Ukraine	0.676	23	2,230,142	16	52,053	18	5,099	119
Slovak Republic	0.479	24	391,385	53	12,502	40	7,171	229
Luxembourg	0.312	25	70,535	110	818	114	11,266	131

Source: the data of European economies, see International Monetary Fund World Economic Outlook (October-2019), 2020.02.24. http://statisticstimes.com/economy/european-countries-by-gdp.php; The data of the Covid-19 in the Europan region, see https://voice.baidu.com/act/newpneumonia/newpneumonia, 2021.07.19.

centres to manage the crisis. These actions provided quarantine facilities for people suspected of having the virus. However, the community model of social quarantine played a key role in disease prevention, thereby suppressing the local transmission rates successfully (57, 58). From the SARS experience, China recognised the value of community control as the most effective way to combat a pandemic. The most fundamental duties of the community mode are lockdowns, conducting checkpoints, community blockades, and "family outdoor restriction" policies. City lockdown policies and traffic bans or restrictions were enforced for social quarantine when the features of COVID-19 were unknown and the vaccine was in its experimental phase.

For policies to promote social quarantine through community actions, the system was supported by voluntary groups who provided services for infected (or suspected) patients isolated at their homes in the local community. Volunteers delivered door-to-door services to families in lockdown and collected their waste. Many governmental and non-governmental organisations encouraged their employees to "voluntarily" protect and monitor lockdowns to prevent the virus. With regard to psychological effects, the psychological model of social quarantine is equally applicable. As Shen et al. (59) described, contact tracing and isolation of close contacts (preventing infection before symptoms occur) can release the psychological stress of COVID-19. However, as the special feature of antivirtue actions, China has an advantage in organising a community system, which provides social services and local control through national recommendations and information guidelines.

The Scandinavian Experience of Behavioural Mode

In Scandinavian countries, the herd immunity theory is a hot topic for popular debates, making many people resist community control to defend their right to freedom. Under the influence of herd immunity, the community mode of social quarantine is weakly implemented. People make voluntary choices between the coercive and voluntary practise of social distancing. In Sweden, people maintained daily maintenance of shops, schools, and their social lives, and applied limited virus testing in the early phase, reserving testing only for those with severe symptoms. To reserve health resources, community control is not strictly adhered to. Denmark and Norway imposed relatively

strong restrictions against public gatherings, but specific decision are still dependant on the circumstances. Finland closed high schools and universities, but kindergartens and primary schools remained open from grades 1–3 to support working parents (60).

Thus, a behaviour model is stressed and residents were required to restrict unnecessary travel. However, a solution of voluntary distancing is very much subject to the behavioural norms, though there were rules restricting gatherings of more than 10 people in all these Scandinavian countries. Despite an open view on community control and lockdown policies in the clinic and community models, outreach initiatives and collaboration on communication strategies are vital to ensure compliance. Compliance with quarantine measures depends on a number of factors or strategies used by the authorities responsible for the emergent management. This leads to diverse policy practises from radical Sweden (which adopted an open-door policy) to conservative Finland, whereas Denmark and Norway were somewhere in between.

In consequence, if we calculate the number of infected cases and the mortality rate per 100,000 of the population, they were 5,011 and 43 in Denmark, respectively; 1,708 and 18 in Finland, respectively; and 2,413 and 15 in Norway, respectively. These figures indicate a very low level of infection among the Scandinavian states, but a high rate of Sweden (10,502 and 141, respectively) (see **Table 1**). Since success or failure of pandemic control in Finland and Sweden is highly due to their different attitude towards quarantine in their behavioural modes, the behavioural mode contributes great to explain the diversity of the outcome in the prevention of the pandemic.

Within this four-mode frame of social quarantine, we review theoretical studies and discuss different strategies of anti-virus policies. The two factors are timing, which affects the features of the development process of the pandemic in the country (and the world), and context, the sociocultural conditions and social environment in which the policy is enforced. For timing, a country may conduct a strict control policy in the clinical and community modes once the infection rate becomes high or may alternatively put increasing emphasis on the behavioural and psychological modes of social quarantine when the spread of the virus is reduced, giving authorities time to find decisive treatments, such as vaccines. In countries, such as China, Italy, and India, large-scale quarantine strategies were implemented to level their COVID-19 infection curves, but the effective of the pandemic control is varied in these societies due to their dissimilar sociocultural contexts and political institution affecting their policy practises in these four modes.

THE RELATIONSHIP BETWEEN MODES

Social quarantine has been applied to reduce mortality and morbidity, and social distancing is the fundamental way to avoid transmission of infection. However, debates over social quarantine measures were engaged in by many observers, since they generate problems in maintaining people's daily lives and restoring the economic system. This study discusses the concept of social quarantine and recognises its different modes. It presents four modes of social quarantine and discusses their features, outlining them from different perspectives. Using this analysis framework, we define the complex meanings of this concept and explore the relationships of these four modes.

The effect of using the four-modes concept can be tested by the following key issues: (1) public health and the individual's daily life, (2) clinical needs and economical operation, and (3) community actions and psychological reaction. The answers will be complicated, reflected from both macro- and micro-level perspectives to integrate the conflicting needs of control and freedom. In relation to the first issue, we can expose the way to bridge the social perspective (of public health) to the individual perspective (of everyday life). With the four-mode concept, we discuss the clinical and community modes to underscore the meaning of social control, whereas the application of behavioural control and psychological modes brings the values of public interest and individual freedom together. Indeed, we can hardly capture these different states of quarantine by addressing social quarantine simply as a generalised concept without classification.

The most fundamental debate over the quarantine policy is the conflict between health and economic benefits, i.e., the aforementioned second issue. To achieve the successful control of public health against viral infection, we need to run the clinical and community modes of social quarantine with strict restrictions to mobility. This restriction will, however, create difficulties for the economy to operate. Thus, finding a way to comply with both sides of this demand is essential. The four-mode concepts may help to meet this need. For instance, we can apply the behavioural mode to continue constraining mobility across regions for public health after the end of community lockdowns. As observed, though many cities changed their policy from a lockdown to an open-door policy for economic recovery, the need (for quarantine) remains.

Thus, with the help of this four-mode model, we can apply the behavioural mode to everyday life to exercise quarantine norms. This mode embodies the principle of social quarantine into daily activities, such as handwashing, avoiding shared materials, and ventilating rooms. We can accept these behavioural norms, patterns, and regulations as the soft measures of social quarantine to achieve the desired effect instead of adopting hard measures of community lockdown and interruption to the economy. Accordingly, this four-mode classification may enable us to develop the analysis in a detailed and operational way and thus ensure the behavioural mode plays its role in social distancing.

In response to the third issue, the community mode takes a macro-level stance, whereas the psychological mode outlines individual standards of quarantine. Among these four modes, we regard the community mode as the most essential part of the quarantine concept. This mode emphasises solidarity and altruism as the normative basis of community engagement, with outreach initiatives and collaboration on communication strategies to ensure compliance. These community actions adhere to quarantine measures to flatten the infection curve, and they engage volunteers as actors in social quarantine by working as data accumulators and local inspectors at checkpoints and servicing locally isolated families. These

volunteers remain in the neighbourhood to ensure that inhabitants wear a mask, test their temperature when in public, or ensure that contaminated individuals go to a quarantine centre.

Meanwhile, the psychological issue should not be neglected. The experience of quarantine may lead to long-term mental health issues; for example, a study conducted by Liu et al. (13) reported that social quarantine is understood in the sense of clinical and community work. The four-mode concept stresses the behavioural and psychological modes, which can mutually support the macro- and micro-level viewpoints or subjective and objective indicators. Some research showed that people under quarantine might express fixation on the disease and feelings of loneliness, anxiety, and depression. Loneliness may act as a stressor that produces negative effects, such as a high level of perceived stress. People also suffer from uncertainty, and may be eager to express concerns over time and seek guidelines for future development. Thus, we shall underscore the community and behavioural modes for this study, which give fundamental reasons for explaining cross-country differences.

Overall, in studies of the issue of social quarantining, researchers refer to clinical measures and community actions, which also affect the policy-making process. With this view, the tasks of community control and individual freedom, as well as economic operation, seem to be conflicting. This contrast between behavioural restrictions and individual freedom also causes criticism, as Tognotti (3) maintained that the contradiction between individual freedom and public health often causes a debate for both theoretical and practical reasons. This study analyses the conceptual and theoretical perceptions, which opens a new way of discussion on this issue by extending four dimensions of understanding about the social quarantine ideal. It not only brings out a framework of analysis for the detailed description of quarantine practises in different societies, but also provides the inner logic of these different dimensions, which helps in outlining our policy choices and development strategies to cope with the current challenge of COVID-19.

CONCLUSIONS

As the pandemic persists, we must face conflicting tasks of disease prevention, normalisation of our lives, and the operation of the economic system. Thus, we should adopt multiple dimensions of work, perhaps not by making policy choices but rather by adopting different kinds of policies simultaneously. This demands a better understanding of the nature and features of these policy measures, with some on healthcare and illness prevention and others stimulating economic activities or normalising daily life. The proposal of adopting four modes of social quarantine helps to achieve such aims with different policies. We may use the clinical and

community modes for mutual support with strict measurements to control the pandemic adopted at the same time as supporting hard control for the behavioural and psychological modes. Alternatively, once the situation is modified, we may maintain social control by implementing the behavioural and psychological modes of social distancing as the soft measures, with a lesser degree of control with regard to the clinical and community modes. This provides a large space for policy choice, and the overall effects of these policies should be carefully evaluated.

Meanwhile, we also observe the policy choices each country makes to deal with their sociocultural contexts. Taking the example of community lockdown strategy used in many European cities, this policy seems difficult to implement, as people still move around cities even after implementing this policy. This condition is in part dependant on the local tradition of community administration, as in China, where there is a mature system of community administration, which is empowered and contributes greatly to local control in this pandemic. However, this civil administration system is lacking in Scandinavian countries, so the community mode of social quarantine could hardly be implemented effectively. Thus, the application of these different quarantine modes is subject to the local conditions and "historical moments" of the pandemic, which leaves a wide space for policy choices, contextual studies, and interpretation of the policy options for development within certain sociocultural contexts. Accordingly, the presented proposal of the four-mode ideal is useful to deepen our understanding of the nature of quarantine measures in various types and the contextual and institutional reasons that limit flexibility for policy choices.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

AUTHOR CONTRIBUTIONS

KL contributed to the main conceptual ideas, design and research framework, and involved in the drafting process including full manuscript revision. AM drafted the section 3 and 4, aided in interpreting the references and results. MAR contributed in drafting section 1 and 2. KM contributed to the manuscript drafting and proof reading. All authors contributed to the final revision of the manuscript.

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The Nasopharynx Swab Test for Coronavirus Disease-2019 Is Mild and Will Not Cause Significant Pain and Anxiety: A Cross-Sectional Study Based on Psychiatrists

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Background: Laboratory viral nucleic acid testing (NAT), such as the nasopharyngeal swab test, is now recommended as the gold standard for the diagnosis of Coronavirus disease-2019 (COVID-19). However, the nasopharyngeal swab testing process may cause some discomfort.

Objective: To investigate the influence of nasopharyngeal swab tests on the anxiety and pain felt by psychiatric medical staff.

Methods: A total of 174 psychiatric medical staff (namely 97 doctors, 68 nurses, and nine administrators) and 27 controls were included in the current study. A self-designed questionnaire was used to collect their general demographic information (age, gender, marriage, occupation, profession, smoking history, alcohol consumption history, tea drinking history, previous history of anxiety and depression) as well as their subjective experience, such as nausea, vomiting, coughing, worry, fear, etc, during nasopharyngeal swab collection. The Numerical Rating Scale (NRS) and the State-Trait Anxiety Inventory (STAI) were used to assess the subjects' pain and state anxiety, respectively.

Results: There were no statistical differences ($p > 0.05$) in age, marriage, smoking history, a history of anxiety and depression, pain scores, and anxiety scores between different professions and genders. The results of partial correlation analysis (controlled for gender and history of depression or anxiety) indicated that the male gender was negatively correlated with being anxious ($r = -0.148$, $p = 0.037$) and nervous ($r = -0.171$ $p = 0.016$), although there was no significant difference in pain and anxiety between men and women. In addition, marriage might help women resist negative emotions.

Conclusions: 1) There will be mild discomfort during nucleic acid testing, but not enough to cause pain and anxiety; 2) women are more likely to be anxious and nervous during the nucleic acid testing.

Keywords: COVID-19, women, anxious, nervous, nasopharyngeal swab test

INTRODUCTION

Coronavirus disease-2019(COVID-19) has been spreading globally since the end of 2019. As of March 10, 2020, the global number of confirmed cases of COVID-19 has surpassed 118 000, and most cases (68.42%) occurred in China (Pan et al., 2020). To identify infected patients and begin clinical treatment in a timely manner, starting from January 15, 2020, the Chinese government issued seven successive versions of COVID-19 diagnostic and treatment guidelines. Laboratory viral nucleic acid testing (NAT), such as the nasopharyngeal swab test, is now recommended as the gold standard for the diagnosis of COVID-19 (Pan et al., 2020), and it has proven to be one of the most quickly established laboratory diagnosis methods in a novel viral pandemic, which can serve efficiently to confirm COVID-19 infection within 2 h (Liu et al., 2020).

Nasopharyngeal swab tests can be performed on several types of upper respiratory specimens, including washes, swabs, and aspirates (Frazee et al., 2018), however, it may cause some degree of discomfort, such as nausea and coughing, although they can be tolerated (Hansen et al., 2016). To our knowledge, there have been no studies exploring the severity of discomfort caused by nasopharyngeal swab tests and their associated factors. Therefore, we conducted this cross-sectional study to specifically examine the level of discomfort associated with the detection of COVID-19 by nasopharyngeal swabs among Chinese psychiatric medical staff.

MATERIALS AND METHODS

Participants

This cross-sectional study was conducted with psychiatric medical staff from Shanghai mental health center between July 2 and 9, 2020. The inclusion criteria were as follows: 1) participants had taken a nucleic acid test within the past week; 2) nasal and pharyngeal swabs were tested simultaneously; 3) participants had to be Shanghai Mental Health Center staff, including doctors, nurses, and administrative staff; and 4) they were willing to be investigated. Exclusion criteria were as follows: 1) nucleic acid tests took more than a week; 2) non-psychiatric related major; 3) only nasal or pharyngeal swabs were performed; 4) the onset of anxiety and depression; or 5) participants refused to be investigated. Finally, 174 psychiatric medical staff working in Shanghai mental health center and 27 controls (such as family members or nursing workers of medical personnel) were enrolled in the study.

Ethical approval was issued by the Ethics Committee of Shanghai Mental Health Center, and all the participants had signed informed consent before the study was initiated.

Investigation Tools

By using a self-designed questionnaire, we have obtained the general demographic information of the respondents, including their age, gender, marriage, occupation, profession, smoking history, alcohol consumption history, tea drinking history, previous history of anxiety and depression, as well as their subjective experience, such as nausea, vomiting, coughing, worry, fear, etc during nasopharyngeal swab collection.

Psychopathology Batteries

The Numerical Rating Scale (NRS) and the State-Trait Anxiety Inventory (STAI) were used to assess the subjects' pain and state anxiety, respectively. The numeral assessment scale represents the pain degree by 11 Numbers from 0 to 10, 0 means no pain, 10 means the most pain, and the subjects will select one of the Numbers according to his/her personal pain feeling, to represent his/her pain degree (Wikstrom et al., 2019). The NRS has become the most recommended scale as a result of patients' preferences regardless of context and age (Hjermstad et al., 2011). The STAI was used to assess the participants' state anxiety (i.e., feelings of anxiety at a given moment) (Wu et al., 2019). Each item is evaluated based on the severity of the symptoms (1 = not at all, 2 = some, 3 = moderate, 4 = very obvious). The STAI scores range from 20 to 80, with higher scores indicating more severe symptoms, and a score of 45.13 is considered as the cut-off value to determine whether the participants have anxiety (Abed et al., 2011).

Investigation Method

In the current study, we used the Electronic "Questionnaire Star" as the surveying tool, and information was collected through WeChat friends circle forwarding. "Questionnaire Star" is a specialized online platform for questionnaire evaluation, voting, and other purposes. Compared with the traditional survey methods, "Questionnaire Star" has the obvious advantages of being a fast, low cost, and easy to learn, surveying tool (Li et al., 2019).

Definition of Specific Variables

We used standardized questionnaires to collect the general demographic data of the respondents, such as their age, gender, profession, marital status, and feelings during nucleic acid testing, such as nausea, vomiting, coughing, and so on. All of the questions regarding the feelings during nucleic acid testing were answered as "yes" or "no".

Data Analysis

The continuous variables were expressed as the mean ± standard deviation, and the categorical variables were represented by frequency (%). The one-sample Kolmogorov-Smirnov test was utilized to explore whether the data were normally distributed. The chi-square test was used to compare the categorical variables, while the t-test and Mann-Whitney U-test were used to compare the continuous variables that did and did not have a normal distribution, respectively. Partial correlation analysis was used to assess the association between worry/fear and gender, and we had controlled for profession, smoking, and drinking tea. Correlation analysis was used to explore the relationship between NRS and STAI, and single factor ANOVA analysis was used to explore the impact of marriage on NRS and STAI scores in women. IBM SPSS Statistics for Windows, version 22.0 (IBM Corp., Armonk, NY, USA) was used for the statistical analysis. A p-value < 0.05 was considered significant.

RESULTS

General Demographic Data of the Psychiatric Medical Staff

We enrolled 201 participants in this study. Of them, 97 were doctors, which accounted for 48.3%, 68(33.8%) were nurses, nine (4.5%) were administrators, and 27(13.4%) were others. 118 (58.7%) felt nausea, 109(54.2%)felt nervous, 80(39.8%) felt anxious, 34(16.9%) coughed, 22 (10.9%) vomited, 5(2.5%) felt bronchospasm, 7(3.5%) felt dyspnea, and 7(3.5%) worried about pharyngeal infection. **Figure 1** presents the results. There were statistical differences (p<0.05) between professions, tea drinkers, alcohol drinkers, those who felt anxious, and those who felt nervous between the male group and the female group, while there were no statistical differences (p>0.05) in age, marriage, smoking history, a history of anxiety and depression, pain scores and anxiety scores. **Table 1** shows the results.

Comparison of Pain Scores and Anxiety Scores in Nucleic Acid Testing Between Medical Staff and Non-Medical Staff

Next, we classified 97 doctors, 68 nurses, and nine administrative staff into the medical staff group and the remaining 27 participants into the non-medical staff group, and compared the NRS and STAI scores between the two groups. Finally, we found no statistical difference (p>0.05) in NRS (3.80 ± 2.109 *vs* 3.22 ± 1.783) and STAI (31.57 ± 10.847 *vs* 29.70 ± 7.032) scores between the two groups, suggesting that there was no difference in the tolerance of medical personnel and non-medical personnel to nucleic acid testing.

Relationship Between NRS Scale and STAI Scale

By using correlation analysis, we found that the total score of NRS was significantly correlated with the total score of STAI. **Figure 2** shows the results.

The Relationship Between Gender and Anxious/and Nervous

The results of partial correlation analysis (controlled for profession, alcohol drinking, and tea drinking) indicated that the male gender was negatively correlated with feeling anxious (r=-0.148, p=0.037) and nervous (r=-0.171 p=0.016).

The Effect of Marital Status on Women's NRS Score and STAI Score

In order to explore the impact of marriage on women's NRS score and STAI score, we then applied one-way ANOVA analysis LSD test, and finally found that married women scored less on NRS and STAI than unmarried women, while there was no statistical difference between the divorced group and the unmarried group, suggesting that marriage might help relieve women's pain and anxiety. **Tables 2** and **3** present the results.

DISCUSSION

To my knowledge, this is the first study to explore the level of discomfort associated with the detection of COVID-19 by nasopharyngeal swabs among Chinese psychiatric medical staff, and we have got some interesting results: 1) there was mild discomfort during nucleic acid testing, but not enough to cause pain and anxiety; 2) there was no significant difference in discomfort between medical staff and non-medical staff during the process of nucleic acid testing; 3) women were more likely to be anxious and nervous during the nucleic acid testing; and 4) marriage might help relieve women's pain and anxiety.

COVID-19 is associated with human-to-human transmission and has recently been found in the saliva of infected patients. Salivary diagnostics may provide an easy and cheap platform for early and quick diagnosis of COVID-19 (Sabino-Silva et al., 2020), so the oropharyngeal and nasopharyngeal (OP/NP) samples have been commonly used as a screening tool (Winichakoon et al., 2020). However, the process of taking a
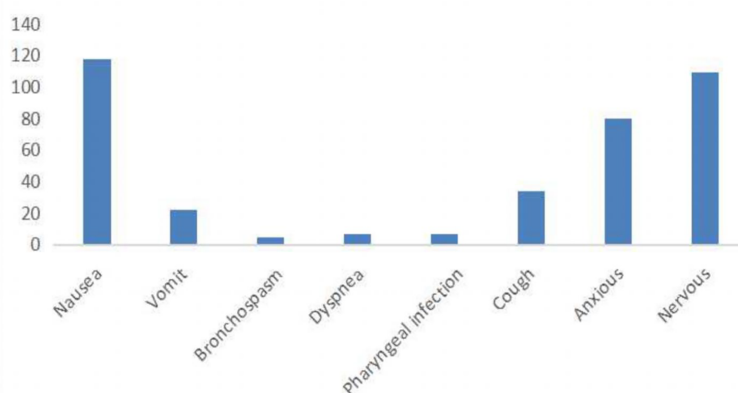

FIGURE 1 | Common adverse reactions in nucleic acid testing.

TABLE 1 | General demographic information of the subjects.

Variables	Total (n = 201)	Male (n = 34)	Female (n = 167)	p
Marriage				
Married, n (%)	141 (70.1)	22 (64.7)	119 (71.3)	0.721
Not married,n (%)	56 (27.9)	11 (32.4)	45 (26.9)	
Divorced,n (%)	4 (2.0)	1 (2.9)	3 (1.8)	
Profession				
Doctors,n (%)	97 (48.3)	22 (64.7)	75 (44.9)	<0.001*
Nurses,n (%)	68 (33.8)	1 (2.9)	67 (40.1)	
Administrators,n (%)	9 (4.5)	3 (8.8)	6 (3.6)	
Others, n (%)	27 (13.4)	8 (23.5)	19 (11.4)	
Smoker				
Yes,n (%)	8 (4.0)	3 (8.8)	5 (3.0)	0.136
No,n (%)	193 (96.0)	31 (91.2)	162 (97)	
Alcohol drinker				
Yes,n (%)	23 (11.4)	14 (41.2)	9 (5.4)	<0.001*
No,n (%)	178 (88.6)	20 (58.8)	158 (94.6)	
Tea drinker				
Yes,n (%)	89 (44.3)	22 (64.7)	67 (40.1)	0.013*
No,n (%)	112 (55.7)	12 (35.3)	100 (59.9)	
A history of anxiety and depression				
Yes,n (%)	8 (4.0)	2 (5.9)	6 (3.6)	0.625
No,n (%)	193 (96.0)	32 (94.1)	161 (96.4)	
Feeling of nucleic acid detection				
Nausea,n (%)	118 (58.7)	20 (58.8)	98 (58.7)	1.000
Vomit,n (%)	22 (10.9)	2 (5.9)	20 (12.0)	0.382
Bronchospasm,n (%)	5 (2.5)	1 (2.9)	4 (2.4)	1.000
Dyspnea, n (%)	7 (3.5)	3 (8.8)	4 (2.4)	0.096
Pharyngeal infection, n (%)	7 (3.5)	1 (2.9)	6 (3.6)	1.000
Cough, n (%)	34 (16.9)	4 (11.8)	30 (18.0)	0.461
Feel anxious, n (%)	80 (39.8)	7 (20.6)	73 (43.7)	0.013*
Feel nervous, n (%)	109 (54.2)	10 (29.4)	99 (59.3)	0.002*
Anxiety based on State Anxiety Inventory				
Yes,n (%)	19 (9.5)	2 (5.9)	17 (10.2)	0.747
No,n (%)	182 (90.5)	32 (94.1)	150 (89.8)	
Age, y	34.58 ± 7.758	35.24 ± 8.818	34.44 ± 7.551	0.590
Pain scores	3.73 ± 2.074	3.82 ± 2.443	3.71 ± 1.998	0.765
Anxiety scores	31.32 ± 10.422	30.44 ± 12.524	31.50 ± 9.974	0.592

*$p < 0.05$.
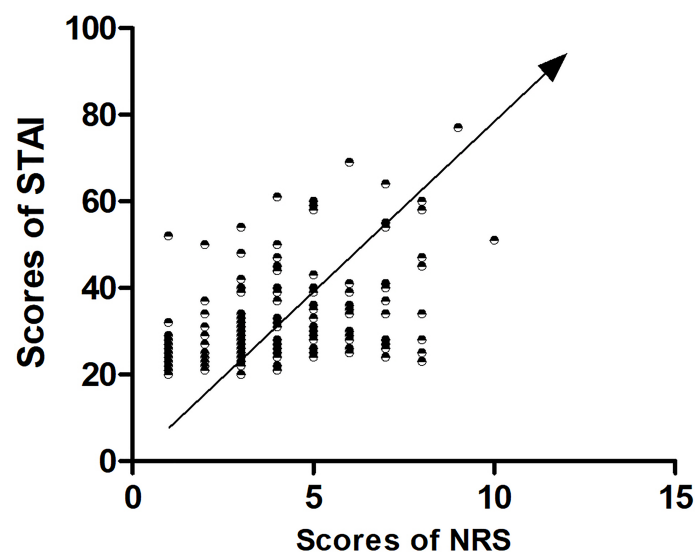
FIGURE 2 | Correlation between NRS and STAI.

Variables	Married (n = 119)	Unmarried (n = 45)	Divorced (n = 3)	F	p
Total STAI score	30.62 ± 9.246	34.27 ± 11.525	24.67 ± 1.528	2.965	0.054
Total NRS score	3.48 ± 1.948	4.40 ± 1.970	2.33 ± 2.309	4.361	0.014*

*p < 0.05.

TABLE 3 | The effect of different marital status on women's NRS score and STAI score (LSD).

Variables	Marriage (i)	Marriage (ii)	Mean difference (i-ii)	S.E	p	95%confidence interval
Total STAI score	Married	Unmarried	-3.645	1.725	0.036*	-7.051~-0.238
		Divorced	5.955	5.763	0.303	-5.424~17.334
	Unmarried	Divorced	9.600	5.878	0.104	-2.007~21.207
Total NRS score	Married	Unmarried	-0.921	0.343	0.008*	-1.600~-0.240
		Divorced	1.146	1.145	0.319	-1.120~3.410
	Unmarried	Divorced	2.067	1.168	0.079	-0.24~4.37

*p < 0.05.

saliva sample can cause discomfort, such as nausea or bleeding, which may not be appropriate for all populations, especially those with thrombocytopenia (Sri Santosh et al., 2020). What's more, it can also put health-care workers at risk of infection, so many people have expressed their nervousness and concern.

Because of the closed working environment in psychiatric hospitals, which are more prone to cluster infections, the Chinese government requires employees in every psychiatric hospital to undergo nucleic acid testing. In the current study, we investigated the pain and anxiety levels of psychiatric medical staff in Shanghai mental health center during nucleic acid testing (by nasopharyngeal swab) and found that the most common symptoms during nasopharyngeal swabs were nausea, nervousness, anxiety, coughing, and vomiting. However, these symptoms were mild and did not cause significant pain or anxiety. In addition, we investigated the emotional responses of medical staff and non-medical staff during the nucleic acid testing process, and we found no difference in pain and anxiety between the two groups, suggesting that the nucleic acid testing process did not cause too much pain and panic.

Next, we explored the factors that influence feeling anxious and nervous, and the results of partial correlation analysis (controlled for gender and history of depression or anxiety) indicated that women were positively correlated with feeling anxious and nervous, which was consistent with previous findings (Reisner et al., 2016; Howell and Weeks, 2017; Barbaro et al., 2018). However, we did not find that there was any effect of different occupations on feeling anxious and nervous, suggesting that this emotional response is universal, therefore, we should give more attention to women and do a good job in health education.

There are several mechanisms that might explain why women are more prone to negative emotions. First, women tend to show high anxiety and adopt negative ways to deal with negative emotions (Qi et al., 2020). Second, women are more likely to experience certain types of stressors, such as sexual trauma (Mayor, 2015). Third, higher negative emotions in women are associated with more severe mood disorders and are associated with depression, anxiety, and substance use disorders (Brady and Sinha, 2005). Fourth, compared with men, women reported greater sadness, anxiety, and physical feelings caused by stress when facing the same stress (Guinle and Sinha,

2020). What's more, genes, hormones, and brain structure may also play a role in women's moods (Gibson et al., 2011; Albert et al., 2015; Lamers et al., 2019; Robakis et al., 2019; Bower et al., 2020). Interestingly, we found that marriage helps women resist negative emotions, which was consistent with other studies (Kiecolt-Glaser and Newton, 2001; Boerner et al., 2014). We speculate that marriage provides women with security and emotional support and helps them cope with negative emotions in a positive way.

Finally, through correlation analysis, we found a positive correlation between the total score of NRS and the total score of STAI (**Figure 2**), suggesting that anxiety and pain are closely related. In fact, anxiety and pain often go hand in hand, and it is hard to pinpoint their cause and effect. Similarly, since our current study was only a cross-sectional study, we could not continue to analyze the internal relationship between the two factors, which was a limitation of our current study.

We have to admit that our study has certain limitations: first, it was just a cross-sectional study that could not establish a causal link between gender and emotional response; second, our sample size was relatively small, which reduces the reliability of the study.

CONCLUSIONS

The discomfort of COVID-19 detected by nasopharynx swab is mild, and will not cause obvious pain and anxiety, however, it is still necessary to pay attention to the adverse emotional reactions of women.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Ethics Committee of Ethics Committee of

Shanghai Mental Health Center. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

WL and GL contributed to the study concept and design. QG and HZ collected the data. WL analyzed the data and drafted the manuscript. All authors contributed to the article and approved the submitted version.

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Not One Pandemic: A Multilevel Mixture Model Investigation of the Relationship Between Poverty and the Course of the COVID-19 Pandemic Death Rate in the United States

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The COVID-19 pandemic, which began in China in late 2019, and subsequently spread across the world during the first several months of 2020, has had a dramatic impact on all facets of life. At the same time, it has not manifested in the same way in every nation. Some countries experienced a large initial spike in cases and deaths, followed by a rapid decline, whereas others had relatively low rates of both outcomes throughout the first half of 2020. The United States experienced a unique pattern of the virus, with a large initial spike, followed by a moderate decline in cases, followed by second and then third spikes. In addition, research has shown that in the United States the severity of the pandemic has been associated with poverty and access to health care services. This study was designed to examine whether the course of the pandemic has been uniform across America, and if not how it differed, particularly with respect to poverty. Results of a random intercept multilevel mixture model revealed that the pandemic followed four distinct paths in the country. The least ethnically diverse (85.1% white population) and most rural (82.8% rural residents) counties had the lowest death rates (0.06/1000) and the weakest link between deaths due to COVID-19 and poverty ($b = 0.03$). In contrast, counties with the highest proportion of urban residents (100%), greatest ethnic diversity (48.2% nonwhite), and highest population density (751.4 people per square mile) had the highest COVID-19 death rates (0.33/1000), and strongest relationship between the COVID-19 death rate and poverty ($b = 46.21$). Given these findings, American policy makers need to consider developing responses to future pandemics that account for local characteristics. These responses must take special account of pandemic responses among people of color, who suffered the highest death rates in the nation.

Keywords: multilevel mixture model, COVID-19, United States, poverty, demographic characteristic

INTRODUCTION

Beginning in late 2019, a novel Coronavirus, later named COVID-19, emerged in Wuhan, China. This virus spread quickly in parts of China, and soon moved to other nations in the region, eventually spreading across the world by the early spring of 2020. The course of this pandemic has varied greatly across nations, with some experiencing steep spikes in the infection and death rates early in 2020 followed by a sharp decline in the summer, and then a rebound in the fall of 2021 (e.g., Italy), with others having consistently lower rates of both outcomes throughout this time period (e.g., Singapore, Korea, and Hong Kong). The United States experienced a somewhat unique course of the pandemic, with an increase in cases through the early spring, followed by a decline in late spring, and then a large spike in case numbers through the summer and into the fall (New York Times, 2020), with much spatial variation in where the spikes occurred at different points in time. This uneven course of the pandemic in the United States hints at its variable course in different parts of the country.

Research, as well as popular media outlets, have reported a link between poverty, ethnicity, and the severity of the pandemic's effects on Americans (Adhikari, et al., 2020; Finch and Hernández Finch, 2020; Goldstein, 2020; Koma, et al., 2020; USA Today, 2020). It is also known that COVID-19 is particularly dangerous for individuals with comorbidities such as diabetes, heart disease, and pulmonary illnesses, all of which tend to be more prevalent in under-resourced communities (Oates, et al., 2017; Williams, et al., 2010; Elo, 2009; Adler and Rehkopf, 2008; Braverman, et al., 2005; Lutfey and Freese, 2005; Link and Phelan, 1995). The impact of these relationships among various COVID-19 and other diseases is exacerbated by the fact that individuals living in under-resourced communities may also lack access to high quality health care (James, et al., 2008; Shi and Stevens, 2005; Lorant, et al., 2002), thereby making the consequence of catching COVID-19 even more severe. The current work follows in the line of research investigating the course of the COVID-19 pandemic over time and for identifying the underlying pattern of spread across the world (Maleki, et al., 2020a; Mahmoudi, et al., 2021b; Maleki, et al., 2020b; Mahmoudi, et al., 2020; Mahmoudi et al., 2021a).

STUDY GOALS

The primary goal of this study was to ascertain whether there existed multiple subsets of counties within the United States with respect to the relationship between poverty and the number of COVID-19 cases, and in terms of the trajectory of the case rate over time. A second goal, assuming that multiple such latent classes were found, was to compare them on a variety of demographic, income, and health outcome variables. Taken together, these two strains of investigation were designed to characterize the nature of the pandemic and its course in the United States throughout January, 2021, in an attempt to better understand how it may, or may not, have impacted different subgroups within the population differently. This study contributes a unique perspective to the COVID-19 literature by identifying differing change trajectories

in the course of the pandemic based upon geography within the United States, and by characterizing these trajectories with respect to a wide array of demographic, economic, educational, and health variables. This comprehensive examination into the course of the COVID-19 pandemic will provide researchers and policy makers with insights that should help drive future research as well as efforts to mitigate the negative impacts of the pandemic in the most severely impacted communities.

METHODS

Data Sources

Several sources were used to obtain the data used in this study. The numbers of confirmed COVID-19 cases and deaths were downloaded from the New York Times at https://github.com/nytimes/covid-19-data on June 8, 2021. A full description of the dataset appears on the data website, with a brief description. County level data were collected from state and local health departments, with the first case in the set being January 21, 2020, and the last case being February 1, 2021, which corresponds to a period immediately prior to the wide scale uptake of COVID-19 vaccinations in the United States. The FIPS code for each county was included in the dataset, which allowed for it to be merged with other datasets that also include this county identifier.

Data on poverty came from the poverty solutions initiative (PSI) at the University of Michigan (https://poverty.umich.edu/about/). Specifically, the Index of Deep Disadvantage, hereafter referred as the poverty index, or index, was used as one of the two primary independent variables in the statistical modeling, which is described below. The poverty index data for each county in the United States, along with the county FIPS code were included in the dataset used in this study. Merging of the data by FIPS code allowed for the matching of poverty index values to the case rates in the NY Times COVID-19 data. The Index of Deep Disadvantage is described in full detail at (https://poverty.umich.edu/files/2020/01/IDD-Technical-documentation-1.pdf).

In addition to the COVID-19 case rates and the poverty index, additional variables describing a variety of income, health, unemployment, and mobility factors for counties in the United States were also used in this study. A full list of these variables, along with their sources appears in **Table 1**. The county demographic data were obtained from the U.S. Census Bureau, education outcomes from the U.S. Department of Education, health indicators from the Centers for Disease Control and Prevention (2020), and income and unemployment data from the U.S. Department of Labor. The indicators of the relative urban and rural natures of the counties were gathered by the Department of Education, and the mobility data were obtained from the website for the Community Mobility Reports project at https://www.google.com/covid19/mobility/.

Variables

The outcome variable of interest in this study was the cumulative numbers of deaths due to COVID-19 cases for each county in the United States. When considering the results of this study it is important to keep in mind that only deaths that have been

TABLE 1 | Variables used in the analyses.

Variable	Source
COVID-19 cases	New York Times COVID-19 project
COVID-19 deaths	New York Times COVID-19 project
Index of Deep Disadvantage	University of Michigan Poverty Solutions Initiative
% less than 18	United States Census Bureau
% 65 and over	United States Census Bureau
% White	United States Census Bureau
% African American	United States Census Bureau
% Latina	United States Census Bureau
% American Indian/Alaska Native	United States Census Bureau
% Asian	United States Census Bureau
% Native Hawaiian/Pacific Islander	United States Census Bureau
% Not proficient in English	United States Census Bureau
High school graduation rate	United States Department of Education
% with access to exercise	United States Centers for Disease Control
% smokers	United States Centers for Disease Control
Age-adjusted death rate	United States Centers for Disease Control
Years of potential life lost	United States Centers for Disease Control
% physically inactive	United States Centers for Disease Control
Infant mortality	United States Centers for Disease Control
Child mortality	United States Centers for Disease Control
Mean number of unhealthy days	United States Centers for Disease Control
% Adults with obesity	United States Centers for Disease Control
% Adults with diabetes	United States Centers for Disease Control
% Fair or poor health	United States Centers for Disease Control
% Vaccinated	United States Centers for Disease Control
% Uninsured	United States Centers for Disease Control
Average daily particulate matter 2.5	United States Centers for Disease Control
80th percentile income	United States Department of Labor
20th percentile income	United States Department of Labor
Income ratio	United States Department of Labor
Median household income	United States Department of Labor
Median household income as percent of state total	United States Department of Labor
% Enrolled free lunch	United States Department of Education
% Unemployment	United States Centers for Disease Control
% Severe housing cost burden	United States Centers for Disease Control
% Homeowners	United States Centers for Disease Control
% Severe housing problems	United States Centers for Disease Control
Overcrowding	United States Centers for Disease Control
%Food insecure	United States Centers for Disease Control
Inadequate facilities	United States Centers for Disease Control
% Limited access to healthy foods	United States Centers for Disease Control
Food environment index	United States Centers for Disease Control
2013 Rural-Urban code	United States Department of Education
Urban influence code	United States Department of Education
Metro	United States Department of Education
Transit stations	Community Mobility Report
Retail/recreation	Community Mobility Report
Workplaces	Community Mobility Report
Residential	Community Mobility Report
Grocery/pharmacy	Community Mobility Report
Parks	Community Mobility Report

confirmed by state and local health authorities are included here. The two independent variables included in the mixture multilevel regression model (described below) were time, operationalized as the week of the pandemic, and the poverty index. COVID-19 case data were combined by week, and week was numbered from 1 to 38.

The poverty index was developed by researchers in the PSI using principal components analysis (PCA). More specifically, the index was the first principal component obtained using PCA involving five features that have been demonstrated to be associated with poverty

and disadvantage (Robles et al., 2019). The researchers reported that this first component accounted for more than 60% of the variance in the set of variables. The weights obtained from the PCA were then applied to the set of constituent variables in order to obtain an index score for each community. After obtaining the index scores, the researchers undertook sensitivity analyses in order to ensure that the index was, in fact, reflecting relative disadvantage as its intent. The results of these sensitivity analyses did indeed support the validity of the index, as reported in Robles, Simington, and Shaefer

TABLE 2 | *t*-statistics for comparisons of mixed effects parameter estimates between pairs of latent classes.

Variable	1 v 2	1 v 3	1 v 4	2 v 3	2 v 4	3 v 4
Week	−27.57*	−19.74*	−30.84*	21.08*	−28.50*	−30.37*
Index	−17.00*	−2.69	−4.61*	15.79*	−3.55*	−4.56*

Bonferroni critical value = 2.88.

*Structure coefficient greater than or equal to 0.4.

(https://poverty.umich.edu/files/2020/01/IDD-Technical-documentation-1.pdf). The index is scaled such that higher values indicate a higher degree of advantage; i.e., relatively more prosperous communities. Thus, lower scores were associated with communities experiencing greater economic disadvantage.

Several variables were used in constructing the poverty index. These include, Chetty and Hendren (2018) estimate of social mobility, life expectancy, percent of residents living below the poverty line, percent of residents living in deep poverty, and the percent of low birth weights. In addition, the PSI also collected other variables that might be associated with poverty, including whether the community was urban or not, and percent of residents with less than a high school diploma. Communities were defined as urban-based on a definition used by the National Center for Health Statistics, and appearing at this website: https://www.cdc.gov/nchs/data_access/urban_rural.htm. Specifically, urban counties contained a metropolitan statistical area (MSA) of 1 million or more individuals, or that have the entire population contained within the largest principal city of the

MSA, or contain at least 250,000 in habitants of any principal city of the MSA. In addition, urban counties were also defined as those with a population of 1,000,000 or higher but which did not meet the aforementioned standards, or those with MSAs of 250,000–999,999.

DATA ANALYSIS

Multilevel Mixture Model

The primary data analytic strategy used in this study was a multilevel mixture model with number of deaths due to COVID-19 per 1,000 residents serving as the dependent variable, and week and the poverty index as the independent variables. The level-2 cluster indicator variable was county. Solutions from 2 to 5 latent classes were fit to the data. In order to determine the appropriate number of classes to retain, several indices were used, including AIC, BIC, sample size adjusted BIC (aBIC), and entropy. These statistics have been shown to be effective tools for determining the number of latent classes to retain (Wang et al., 2017; Nylund et al., 2007). With respect to AIC, BIC, and aBIC, lower values indicate better fit after adjusting for model complexity, meaning that the model with the lowest value is considered to have the best fit. In contrast, the model with the largest entropy (which ranges from 0 to 1) was considered to yield the best fit, with values in excess of 0.8 indicating a well separated set of latent classes (Celeux and Soromenho, 1996).

A random intercept multilevel model with week and the poverty index as independent variables was fit into the data
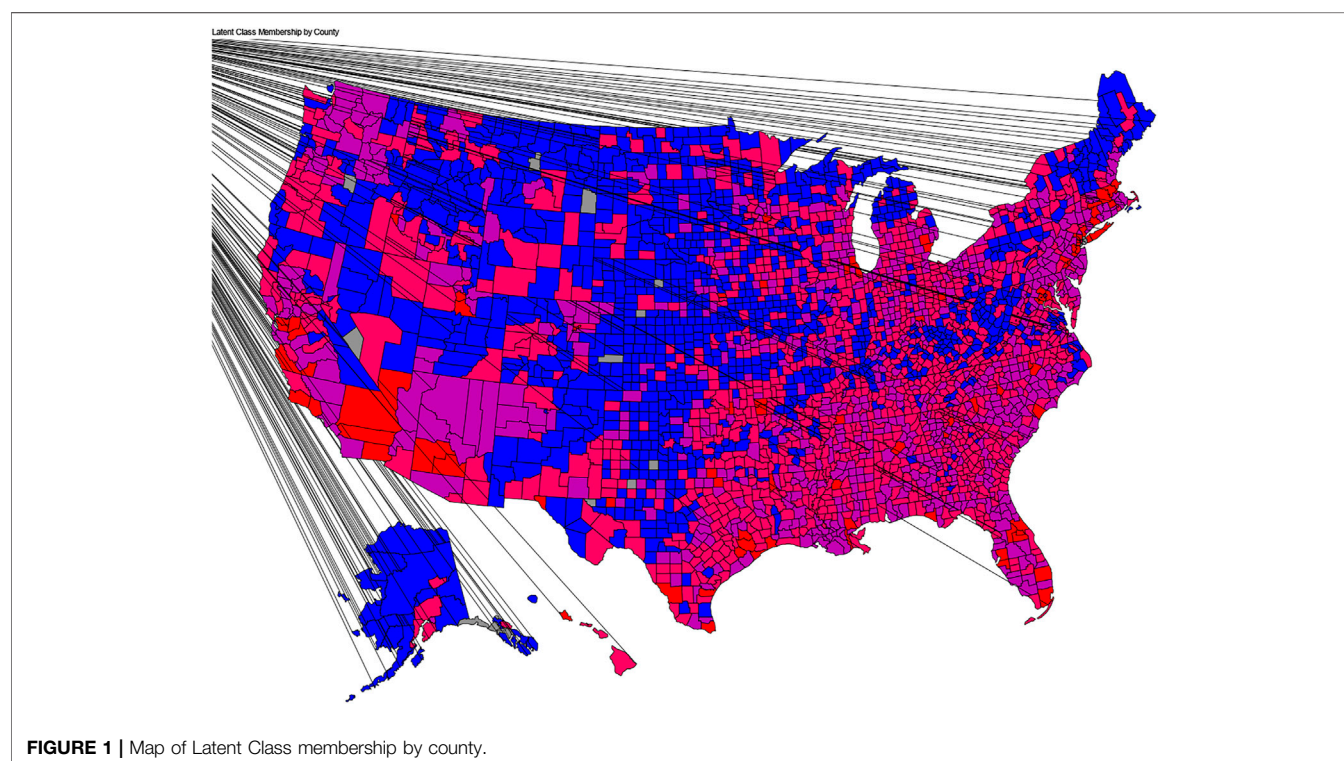

FIGURE 1 | Map of Latent Class membership by county.

TABLE 3 | Mean (standard error) of deaths/1,000 residents and deaths per number of cases by latent class.

Latent class	Mean (standard error)	95% Confidence interval
Deaths per 1,000 residents		
1	0.060 (0.001)	0.058, 0.062
2	0.303 (0.003)	0.297, 0.308
3	0.178 (0.002)	0.174, 0.182
4	0.327 (0.0.01)	0.307, 0.348
Deaths per COVID-19 cases		
1	0.020 (0.0004)	0.019, 0.021
2	0.032 (0.0002)	0.031, 0.033
3	0.027 (0.0003)	0.026, 0.028
4	0.035 (0.0001)	0.034, 0.036

TABLE 4 | Discriminant analysis structure coefficients for demographic variables by latent class.

	Function 1 (84.1%)
% less than 18	−0.19
% 65 and over	0.66[a]
% White	0.59[a]
% African American	0.46[a]
% Latina	−0.26
% American Indian/Alaska Native	0.10
% Asian	−0.52[a]
% Native Hawaiian/Pacific Islander	−0.10
% Not proficient in English	−0.42[a]
High school graduation rate	0.26

[a]*Structure coefficient greater than or equal to 0.4.*

TABLE 5 | Means for demographic variables by latent class.

Variable	Class 1	Class 2	Class 3	Class 4
% less than 18	21.5	22.7	22.2	22.9
% 65 and over[a]	21.7	16.7	18.5	15.1
% White[a]	84.9	67.9	74.8	51.8
% African American[a]	2.5	14.3	11.6	16.4
% Latina	7.5	11.9	8.9	22.6
% American Indian/Alaska Native	2.9	1.7	2.0	1.0
% Asian[a]	0.8	2.7	1.2	6.7
% Native Hawaiian/Pacific Islander	0.1	0.2	0.1	0.2
% Not proficient in English[a]	1.0	2.5	1.5	5.5
High school graduation rate	90.2	87.1	88.6	85.2

[a]*Discriminant analysis structure coefficient greater than or equal to 0.4.*

TABLE 6 | Discriminant analysis structure coefficients for health outcomes by latent class.

	Function 1 (83.3%)
% with access to exercise	0.67[a]
% smokers	−0.49[a]
Age-adjusted death rate	−0.42[a]
Years of potential life lost	−0.40[a]
% physically inactive	−0.40[a]
Infant mortality	−0.38
Child mortality	−0.30
Mean number of unhealthy days	−0.36
% Adults with obesity	−0.47[a]
% Adults with diabetes	−0.42[a]
% Fair or poor health	−0.15
% Vaccinated	0.19
% Uninsured	0.04
Average daily particulate matter 2.5	−0.41[a]

[a]*Structure coefficient greater than or equal to 0.4.*

within the mixture framework. Therefore, the latent classes were differentiated with respect to the magnitudes of the coefficients for these two variables, as well as the estimates of the error and intercept variances. In addition to the model including both week and the poverty index, a null model with no independent variables was fit into the data within each latent class in order to obtain the variance estimates necessary to calculate the intraclass correlation (ICC). The ICC reflects the proportion of variation in the outcome variable (number of cases) that was associated with the level-2 variable (county). Higher levels of the ICC indicate that a greater proportion of the dependent variable variance was associated with the counties.

Discriminant Analysis

In order to further explore the nature of the latent classes defined above, statistics for a number of additional variables were compared across the latent classes. Given the large number of such variables, discriminant analysis (DA) was used, and variables with structure coefficients greater than 0.4 were identified as being associated with the discriminant functions. Discriminant functions that were statistically significant based on the Wilks' Lambda statistic, and that also accounted for more than 10% of the variance in the data were deemed to be worth further discussion. This latter criterion was selected due to the large sample size, all of the hypothesis tests for the discriminant functions were statistically significant.

Thus, it was decided that the function also needed to account for at least 10% of the variance in the differences across the latent classes in order to be worth further discussion. The variables within each set were standardized prior to the fitting of the DA models.

RESULTS

Determining the Number of Latent Classes

The information indices all indicated that the 4 class model was optimal, as seen in **Supplementary Table S1**. The AIC, BIC, and aBIC were all smallest for the 4 class solution, and its entropy was the second largest with classes. In addition, the average latent class probabilities of the most likely latent class were 0.91 or higher for each of the classes (**Supplementary Table S2**). This result suggests that the 4-class solution was very stable, providing additional confidence in its viability. The proportion of counties in each latent class appear in **Supplementary Table S3**. Classes 1 and 3 were the largest, accounting for 33 and 39% of the counties, respectively. Class 4 was the smallest, account for 3% of the counties, and class 3 consisted of 25% of American counties.

TABLE 7 | Means of health outcome variables by latent class.

	Class 1	Class 2	Class 3	Class 4
% with access to exercise*	57.34	72.77	61.31	90.66
% smokers*	16.98	17.14	18.38	14.79
Age-adjusted death rate*	396.42	391.12	433.40	329.22
Years of potential life lost*	8582.00	8070.18	8940.85	6774.57
% physically inactive*	27.07	26.29	28.50	22.75
Infant mortality	9.01	6.53	7.14	5.78
Child mortality	72.94	56.74	63.35	49.84
Mean number of unhealthy days	3.86	3.96	4.15	3.70
% Adults with obesity*	32.28	32.59	34.04	28.08
% Adults with diabetes*	11.58	11.74	13.07	9.73
% Fair or poor health	16.67	17.98	19.11	16.99
% Vaccinated	37.99	46.29	43.18	46.51
% Uninsured	12.83	13.33	14.06	13.10
Average daily particulate matter 2.5*	7.99	8.82	9.57	10.15

*Structure coefficient greater than or equal to 0.4.

TABLE 8 | Discriminant analysis structure coefficients for income/employment variables by latent class.

	Function 1 (84.5%)
80th percentile income	0.77[a]
20th percentile income	0.40[a]
Income ratio	0.29
Median household income	0.62[a]
Median household income as percent of state total	0.59[a]
% Unemployment	−0.03

[a]Structure coefficient greater than or equal to 0.4.

Model Parameter Estimates by Latent Classes

Supplementary Table S3 also displays the GCM model parameter estimates for each latent class. In addition, the table includes the mean of the poverty index, and the ICC associated with county for each class. For all of the classes, the relationship between week and the number of deaths per 1,000 population was positive, indicating that the number of deaths increased in value over time. In addition, for each of the classes, the relationship between the poverty index and number of cases was negative, indicating that poorer counties had a higher number of cases per 100,000 residents. Overall, the coefficient linking time to the number of deaths per 1,000 was significantly different for all pairwise comparisons of the classes (**Table 2**). This result indicates that the latent classes did indeed differ in terms of the course of the pandemic over time. The coefficient for the poverty index also differed significantly between all pairs of classes, except for 1 and 3.

The distribution of latent classes by counties appears in **Figure 1**. Class 1 was centered primarily in the middle of the United States, with some pockets in the northern portions of each coast. Class 4 was centered primarily in urban areas along the east and west coasts, as well as in cities such as Chicago, Atlanta, Detroit, Houston, and Dallas. Classes 2 and 3 were found throughout the United States, with particularly concentrations in the southeast and midwest.

In addition to the overall results described above, there were a number of class specific estimates of interest. The results in **Table 2**, **Supplementary Table S3** reveal for the counties in Class 1, the relationship between poverty and the death rate was the weakest, and the rate of increase in the number of deaths over time was the slowest. In addition, Class 1 had the highest index value, indicating that its counties were the wealthiest on average. Latent Class 2, which was the second poorest of the four, exhibited the second fastest rate of growth in the number of deaths per week, and had the second strongest relationship between the index and number of COVID-19 cases. The counties in latent Class 3 manifested the second weakest relationship between the poverty index and the number of COVID-19 deaths per 1,000 across the 4 classes. Class 3 also had the second fastest growth rate in the number of deaths over time, and was the poorest. Finally, Class 4 had the strongest relationship between poverty and deaths, and the fastest growth rate in the number of deaths per week. It also consisted of the second wealthiest group of counties. With respect to the ICC, Class 3 exhibited the largest value for this sample (0.49), followed by Class 4 (0.35), with Classes 1 (0.17), 3 (0.16), and 4 (0.15) had comparable ICCs with that for Class 2 (0.11) being slightly lower. These results indicate that county accounted for between 11 and 17% of the variance in the number of deaths per 1,000.

Death Rate

The deaths per 1,000 rate was compared across the latent classes using a nested ANOVA, with county nested in latent class. There was a statistically significant difference among the latent class means, with latent class accounting for 15.3% of the variance in the death rate per 1,000 ($F_{3,78250} = 4704.19$, $p < 0.001$, $\eta2 = 0.153$). The deaths per 1,000 means by latent class appear in **Table 3**. The Tukey-b post hoc test results revealed that the means were all statistically significant from one another, with Class 4 having the highest value, Class 2 the second highest, and Class 1 the lowest death rate per 1,000 residents.

ANOVA results showed that there was also a statistically significant difference in number of deaths per number of cases across the latent classes, with an effect size of 0.007 ($F_{3,78250} = 181.755$, $p < 0.001$, $\eta2 = 0.007$). The means, standard errors, and 95% confidence intervals for the number of deaths per number of

TABLE 9 | Means for income/employment variables by latent class.

	Class 1	Class 2	Class 3	Class 4
80th percentile income[a]	93797.26	108903.84	94792.03	131401.21
20th percentile income[a]	22275.40	24552.83	21275.50	27706.65
Income ratio	4.33	4.60	4.62	4.85
Median household income[a]	50811.26	58411.63	50667.08	68509.26
Median household income as percent of state total[a]	85.30	98.15	87.72	106.47
% Unemployment	4.08	4.05	4.25	4.06

[a]Structure coefficient greater than or equal to 0.4.

TABLE 10 | Discriminant analysis structure coefficients for housing/food variables by latent class.

	Function 1 (88.1%)
% Severe housing cost burden	−0.69[a]
% Homeowners	0.65[a]
% Severe housing problems	−0.58[a]
Overcrowding	−0.22
%Food insecure	−0.10
Inadequate facilities	0.18
% Limited access to healthy foods	0.20
Food environment index	−0.05
Population density	0.64[a]

[a]Structure coefficient greater than or equal to 0.4.

TABLE 11 | Means for housing/food variables by latent class.

	Class 1	Class 2	Class 3	Class 4
% Severe housing cost burden*	11.64	15.37	12.21	16.05
% Homeowners*	75.06	68.30	70.78	61.66
% Severe housing problems*	12.21	15.37	14.19	19.43
Overcrowding	2.07	2.64	2.46	3.66
%Food insecure	12.34	13.33	14.10	12.54
Inadequate facilities	1.47	1.00	1.10	0.91
% Limited access to healthy foods	9.73	7.60	7.32	5.85
Food environment index	7.52	7.53	7.41	7.84
Population density*	13.85	169.97	50.75	751.40

*Structure coefficient greater than or equal to 0.4.

TABLE 12 | Discriminant analysis structure coefficients for urban/rural variables by latent class.

	Function 1 (92.3%)
Rural-Urban code	0.96[a]
Urban influence code	0.86[a]
Metro	−0.67[a]

[a]Structure coefficient greater than or equal to 0.4.

cases appear in **Table 3**. Although statistically significantly different, the mean death rates per number of cases were within 0.015 of one another, with Class 4 having the highest value, and Class 1 the lowest. The relative close proximity of these values, coupled with the low effect size (latent classes accounted for less than 1% of the variance in the deaths per number of cases) suggest that there was little practical difference across the classes for this variable.

Demographic Variables

The first DA function for the comparison of the latent class means for the demographic variables appearing in **Table 4** were statistically significant, and accounted for at least 10% of the variance in the demographic variables. The structure coefficients for the two functions appear in **Table 4**, with coefficients of 0.4 or more denoted with an asterisk. With respect to function 1, the variables 65% and over, white%, African American%, %Asian%, and percentage not proficient in English all had values of 0.4 or more.

The means for each variable within the demographic set by latent class appear in **Table 5**, with variables having structure coefficients denoted with an asterisk. These results reveal that the counties in Class 1 had the highest percent of residents who were 65 years or older, and who were white, and the lowest percent who were African American, Latina, Asian, and not proficient in English. In contrast, Class 4 had the lowest percent of residents who were white, and the highest percent who were Latina, Asian, and not proficient in English, and the lowest percent who were 65 years or older. Latent Classes 2 and 3 had higher percentages of residents who were 65 and over, and white, than did Class 4, but lower than that of Class 1. In addition, Classes 2 and 3 had lower

percentages of residents who were Latina, Asian, and not proficient in English than did Class 4.

Health Indicators

One discriminant function was found to be both statistically significant and accounted for 83.3% of the variance in the group differences across the latent classes for the set of health indicators appearing in **Table 6**. The variables with structure coefficients greater than 0.4 are denoted with an asterisk. The means for all of the health indicators by latent class appear in **Table 7**. Class 4 had the highest percent of individuals with access to regular exercise, the lowest percent of smokers, the lowest age-adjusted death rate, the lowest years of potential life lost, the lowest percent of individuals who were physically inactive, and the lowest percent of residents who were obese, or who had diabetes. Class 1 had the least access to exercise, with Class 3 having the next lowest such percent, and Class 2 the second highest. Class 3 had the highest years of potential life lost, followed by Classes 1 and 4. With regard to percent of smokers, percent physically inactive, percent obese, and with diabetes, Classes 1,2, and 3 had

TABLE 13 | Means for urban/rural variables by latent class.

	Class 1	Class 2	Class 3	Class 4
Rural-Urban code*	6.69	2.97	4.48	1.37
Urban influence code*	7.30	2.89	4.51	1.33
Metro*	0.16	0.69	0.39	1.00

*Structure coefficient greater than or equal to 0.4.

TABLE 14 | Discriminant analysis structure coefficients for mobility changes variables by latent class.

	Function 1 (97.2%)
Transit stations	0.86[a]
Retail/Recreation	0.70[a]
Workplaces	0.64[a]
Residential	−0.61[a]
Grocery/pharmacy	0.51[a]
Parks	0.56[a]

[a]Structure coefficient greater than or equal to 0.4.

TABLE 15 | Means for mobility change variables by latent class.

	Class 1	Class 2	Class 3	Class 4
Transit stations	−28.78	−19.64	−14.54	−36.98
Retail/recreation	−14.68	−13.14	−9.59	−19.66
Workplaces	−22.53	−26.08	−23.32	−31.64
Residential	6.37	8.02	6.64	9.84
Grocery/pharmacy	−3.27	−4.44	−2.88	−9.06
Parks	9.06	19.70	10.42	6.24

TABLE 16 | Correlation coefficients between the number of deaths per 1,000 residents and income and poverty variables within each latent class.

Variable	Class 1	Class 2	Class 3	Class 4
Median income	−0.02	−0.09	−0.19	−0.27
% Enrolled free lunch	0.06	0.18	0.25	0.18
% Unemployed	0.03	0.23	0.19	0.01
80th percentile income	−0.03	−0.03	−0.16	−0.35
20th percentile income	−0.04	−0.12	−0.15	−0.20
% Poverty	0.06	0.22	0.28	0.14

similar results. Finally, Class 1 had the lowest average daily particulate matter values.

Income

For the income and poverty variables, one discriminant function was found to be statistically significant, and accounted for 84.5% of the variation in the class differences across the variables. The variables with structure coefficients greater than 0.4 were 80th percentile income, 20th percentile income, median household income, and median household income as percent of state total (**Table 8**). The means for all of the income variables appear in **Table 9**. Class 4 had the highest 80th percentile income, 20th percentile income, median household income, and median household income as percent of the state total. The lowest

values for these variables belonged to Classes 1 and 3, with Class 2 having the second highest values.

Housing and Food Security

The DA results for the housing and food security variables revealed that function 1 was statistically significant, and accounted for 88.1% of the variance in the housing/food variables. Results in **Table 10** show that the severe housing cost burden percentage, homeowners percentage, severe housing problems percentage, and population density were associated with function 1.

The means of the housing and food security variables appear in **Table 11**. Residents of counties in Class 1 had the lowest percent of residents with a severe housing cost burden, or severe housing problems, population density, and with the highest rate of homeownership. In contrast, the highest severe housing burden, severe housing problem, population density, and lowest homeownership rates were found in Class 4. Classes 2 and 3 had similar values for homeowners percentage. Class 3 had the second lowest percentage of residents with severe housing cost burden, severe housing problems, and population density.

Urban/Rural

Another set of variables to be examined with regard to the latent classes were the urban/rural indicators. One of the discriminant functions was both statistically significant, and accounted for 92.3% of the variance in the separation among the classes. Based on the results in **Table 12**, all three urban/rural variables had structure coefficients of 0.4 or more. The means for these variables by latent class appear in **Table 13**. These results reveal that the counties in Class 1 were the most rural (highest values on rural-urban and urban influence codes, lowest metro value). In contrast, Class 4 included the most urban counties, followed by Class 2. Latent Class 3 was the second least urban based on these variables.

Mobility Changes

One discriminant function was statistically significant and accounted for 97.2% of the variance in separation among the latent classes. Based on **Table 14**, changes for all of the mobility were associated with between the class differences. The means for the mobility changes appear in **Table 15**. Class 4 had the greatest decrease in train station, retail/recreation, workplace, and grocery/pharmacy use. Class 4 also had the largest increase in residential use. Counties in Class 3 experienced the smallest changes in use of transit stations, retail/recreation, and grocery/pharmacy, and along with Class 1 the smallest change in workplace mobility.

Relationship Between Income, Poverty, and Case Rates Within Latent Classes

Finally, the within class correlation coefficients for the relationships between the number of COVID-19 deaths per 1,000 residents with median household income, as well as percent of residents living in poverty, appear in **Table 16**.

Given the large sample sizes, all of these correlations were statistically significant at $\alpha = 0.05$. Therefore, interpretation will focus on the magnitudes of the coefficients, with Cohen's (1988) guidelines used to characterize them as small (0.1–0.3), moderate (0.31–0.5), and large (0.51–1.00). For latent Class 1, the relationships between the case rates and each of the variables in **Table 16** were negligible in size. Similarly, for Class 2 the correlations for 80th percentile income and median income were also in the negligible range. On the other hand, higher values of % enrolled free lunch, % unemployed, and % poverty were associated with higher death rates for counties in this class. For the other two classes, the higher the median household income, 80th percentile income, and 20th percentile income for a county, the lower the number of deaths, with the strongest such relationships occurring for Class 4. In addition, counties with a larger percent of residents who were unemployed, living in poverty, or whose children were on free/reduced lunch at school had more deaths per 1,000 residents.

DISCUSSION

Most of the research investigating the course and impact of the COVID-19 pandemic in the United States has focused on the nation as a whole, or on individual states. Relatively less work has examined more localized effects of the pandemic. In addition, although prior research has established a clear link between poverty and the course of the disease (Adhikari, et al., 2020; Finch and Hernández Finch, 2020; Goldstein, 2020; Koma, et al., 2020), more nuanced investigations of this relationship have largely not been undertaken. Therefore, the goal of this study was to examine the course of the COVID-19 pandemic in the United States from winter 2020 through early summer 2021, and to ascertain whether there existed differential relationships between poverty level within individual counties and the number of deaths due to the virus over time. The results from the mixture multilevel model identified four distinct patterns based on the relationships of poverty and time with the number of COVID-19 deaths. In addition, the identified classes could also be distinguished based upon a number of demographic, income, and health care factors.

Given these findings that there was not a single COVID-19 pandemic within the United States, there are several implications for both policy makers, and researchers. First, it is clear that poverty is an important factor with respect to the number of COVID-19 deaths present in an American county, but that this relationship appears to be dependent to some extent on the level of urbanization and diversity present. In those counties which were largely rural and less diverse (latent classes 1 and 3), poverty was more weakly related to the number of COVID-19 deaths. In contrast, urban locations, particularly those in the latent Class 1 which were the most diverse, manifested stronger relationships between poverty and the COVID-19 death rate. More specifically, counties with higher proportions of residents who identified as white had lower death rates due to COVID-19 than those counties with a higher proportion of nonwhite individuals, and the relationship between poverty and the death rate was stronger in those counties with a greater share of nonwhite residents. This general divide between urban/more diverse and rural/less diverse counties was also clear in terms of the correlations between individual income and poverty variables with the number of COVID-19 cases present in the county. Thus, one challenge for policy makers going forward is to more fully investigate the public health response to COVID-19 and the availability of services for dealing with it within counties with higher proportions of nonwhite residents, and to take corrective measures to ensure that those regions have the resources necessary to deal with large scale health emergencies moving forward.

A second related implication of this study is that among urban locations, both the growth rate in the number of reported deaths, and the relationship between poverty and the number of deaths were largest in the most highly urbanized areas. Latent Classes 2 and 4 were comprised of the most urban counties in the United States, and also exhibited the fastest COVID-19 death growth rates and the strongest relationship between poverty and number of deaths. In addition, among the counties in those classes, those that were the most urbanized and densely populated (Class 4) had the fastest growth in the COVID-19 death rate and the strongest relationship between poverty and the death rate. Thus, policy makers and public health officials should not view all urban areas as the same when it comes to understanding and dealing with the spread of COVID-19. The largest and most densely populated urban centers in the United States had faster growth in the COVID-19 death rates and stronger relationships with poverty, than did the somewhat less populace urban counties, which comprised Class 2. And again, it should be noted that the counties in latent Class 1 were the most ethnically diverse, again highlighting the fact that even among urban counties, where the death rate was highest, those with greater proportions of nonwhite residents had even higher COVID-19 death rates. It is clear that race/ethnicity is an important factor in terms of the COVID-19 death rates across the United States

In contrast to the findings for urban areas, among the more rural counties (latent Classes 1 and 3) the relationship between poverty and the number of cases were quite different. In Class 1, which included the least diverse counties in the nation, the relationship between poverty and the rate of COVID-19 deaths was the weakest, particularly for the individual income and poverty variables. In contrast, the other more rural group (Class 3) exhibited somewhat a stronger relationship between the poverty index and the number of COVID-19 deaths, though still smaller than those exhibited by the two urbanized latent classes. These results once again point to the need for policy makers to consider the variegated nature of the pandemic across the country. Even among counties that shared similarities, such as being predominantly rural for example, there were different experiences of the pandemic both in terms of the raw death rates and its relationship with poverty. In addition, given that the counties in latent class 2 had larger proportions of nonwhite population than those in latent class 1, as well as higher death rates, policy makers must consider the role that ethnicity plays above and beyond poverty, when it comes to the impact of pandemics.

A fourth implication of these results is with respect to the pattern of death rates in the latent classes. These comparisons revealed that the two urbanized classes had the highest death rates per 1,000 residents, and the highest death rates per number of cases. Specifically, Class 4 had the fastest growth rate in the number of cases and the highest death rate per 1,000 residents, as well as the highest death rate per number of cases. The most rural and least diverse counties had the lowest death rates per 1,000 residents and per the number of COVID-19 cases. Of particular interest in this regard was the fact that the counties in Class 4 were collectively the wealthiest in the nation. And yet, they had the highest death rate and the strongest association between poverty and this rate. Given that these counties also had the highest proportion of nonwhite residents in the nation, there appear to be important policy implications regarding disparities in health care services for people of color. The question of the wealthiest counties in the nation, with the greatest access to high quality health care exhibited the highest death rates, and the greatest inequalities of that rate with respect to poverty must be addressed in future research.

A fifth implication of these differences in the course that the pandemic across the United States come in the form of challenges to policy makers and public health officials in terms of trying to craft a coherent and comprehensive policy that will work everywhere. As noted above, the pandemic in rural, predominantly white middle America was very different from the pandemic in highly diverse urban centers, which in turn experienced it differently than the somewhat smaller, poorer cities across the nation. And indeed, even among rural portions of America, the pandemic and associated death rates did not follow a uniform pattern, as seen in the different trajectories and relationships between poverty and COVID-19 deaths between the two primarily rural latent classes (latent Classes 1 and 3). In general, higher rates of poverty were associated with higher rates of death due to the disease, but this relationship was much more variegated than has been previously reported. Thus, moving forward, these results would suggest that the policies for dealing with the pandemic should also be more variegated and more directed than may have been the case heretofore.

Limitations

As with any research, there are a number of limitations to the current study that need to be acknowledged, and which should offer opportunities for future work in this area. First, the model used in the study was fairly simple in nature. Only time and the poverty index were included as predictors. The reason for using this relatively limited model was to allow for a clear focus on the relationship between poverty and the rate of COVID-19 deaths, while accounting for changing course of the pandemic over time. However, there are certainly other variables, and other measures of poverty, which could be included in such an analysis, and which might yield different insights into the nature of the pandemic than those explored here. Thus, future work should expand upon this model by including other variables of interest in the mixture component of the analysis.

A second limitation of this research involves the variables used in the follow up analyses to the initial mixture model. The purpose of the follow-up was to more fully explore the nature of the latent classes as a way of gaining further insights into the interplay between poverty and the course of the pandemic. However, given the limitations of the manuscript length, as well as the desire to keep the results as clear and understandable as possible, some variables that would have been interesting to include were by necessity excluded. In particular, variables regarding health outcome rates for specific ethnic and income groups, as well as variables related to education and the trajectory of income and unemployment over the last 2 decades were not included in this study. It is believed that they might prove to be interesting in terms of further characterizing the latent classes, but given the aforementioned size limitations for the study, the decision was made to exclude them. Future research could pay special attention to these, and other variables, in an attempt to more fully understand the latent classes included in this work.

A third limitation of this study was that the data used in the analysis were at the county, rather than the individual level. Clearly, having person level data would be extremely informative in terms of understanding the nature of the COVID-19 pandemic, and its impact on individuals. However, such data is generally not available, and would likely need to be collected using a dedicated study design and sampling plan. Thus, although limited to some extent by the aggregated nature of the county level data, the current study does allow for an investigation that is nationwide. Nonetheless, future work should focus on specific regions or areas of the country with data at the individual level. This is a particularly important issue for measures of air pollution, which can vary locally within counties. Therefore, using a county level measure of particulate matter in the air at the county level is not ideal. Future work should attempt to obtain more locally specific information about air pollution to be included in the model.

A fourth limitation of the current study is the use of an ecological approach to the data analysis, in which data at the population level (the U.S. counties in this case) serve as the unit of analysis. Although confounding variables have been included in this study (e.g., measures of poverty, health care access, and employment), nuanced relationships among variables that would be possible for individual level data are not available with this population level data. Therefore, results of the multivariate modeling techniques, while informative and providing useful information, must be interpreted with the knowledge that these nuanced relationships cannot be fully explored with the current data structure.

Finally, as with any research focusing on a rapidly changing pandemic, the situation changes quickly. It is simply a reality of such research that changes in the situation on the ground will be continually occurring in such a fluid environment. Nonetheless, we believe that the results presented here provide researchers and policy makers with both a detailed description of the pandemic's course in its first 9 months, as well as with information that can be used to guide future work in this area. It is clear that the pandemic in the United States cannot be viewed as a single event, particularly in the context

of poverty. Thus, despite changes in case rates subsequent to the end of this work, the overall message remains relevant, namely that there is no single pandemic in the country, but rather that it manifests itself differently in different locales.

DATA AVAILABILITY STATEMENT

Publicly available datasets were analyzed in this study. This data can be found here: https://www.nytimes.com/interactive/2020/us/coronavirus-us-cases.html.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

SUPPLEMENTARY MATERIAL

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Knowledge, Attitudes, and Practices Concerning COVID-19 in Bangladesh: A Qualitative Study of Patients With Chronic Illnesses

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The novel coronavirus disease (COVID-19) has posed a serious risk with pre-existing health conditions. This study was conducted to understand the knowledge, attitude, and practices concerning COVID-19 among patients with chronic illnesses in Bangladesh during the pandemic. The study was conducted in Khulna city of Bangladesh following a qualitative research design. We employed telephone interviews to collect data from 40 participants with four common pre-existing chronic illnesses (diabetes, hypertension, respiratory/asthma, and heart disease). Findings show that the majority of the participants had a moderate level of knowledge and an overall positive attitude regarding COVID-19 but appropriate safety practices were often ignored as the pandemic grows older. We also observed that the knowledge, attitude, and practice regarding COVID-19 varied based on age, marital status, education, social class, and rural/urban residence. We concluded that improving medical advice/support, promotion of awareness through mass media, strict monitoring of protective measures and subsidies from the government, and self-consciousness could be effective strategies to mitigate the transmission of the disease and reduce risks for patients with chronic illness in Bangladesh during the COVID-19 pandemic.

Keywords: attitude, Bangladesh, chronic health illnesses, COVID-19, knowledge, practice

INTRODUCTION

The coronavirus disease-2019 (COVID-19) pandemic has disrupted every aspect of human life making people vulnerable to the disease (1). To curb the spread of the coronavirus infection, national and partial closures have already been implemented in most countries around the world. At the same time, countries are following protective safety measures, such as hygiene practices and social distancing, suggested by health experts. Bangladesh, one of the most densely populated countries of the world with a population of 165.2 million, has been highly susceptible to COVID-19 since no proven vaccine or medicine is available for the disease right now (2, 3). There have been 417,475 confirmed COVID-19 cases and 6,036 confirmed deaths owing to the disease in this country so far, and the number is still counting (4). The pandemic can have a serious impact on

the country due to its large population size, vulnerable economy, and weak healthcare system. The healthcare system of Bangladesh is still not well-prepared to face this health emergency (5).

Due to the high transmissibility and unavailability of vaccines at this moment, COVID-19 has become a serious concern for people with chronic illness (3, 4). Under the lockdown situation, these people are facing difficulties in taking regular checkups and emergency services making them more vulnerable. Chronic illnesses, such as heart diseases, diabetes, asthma, hypertension, cancer, and HIV, are the major leading causes of death in almost all countries around the world (6). Although these diseases are common worldwide, the burden of such diseases is much higher in developing countries than the developed ones (7).

Knowledge regarding the disease, attitude toward it, and the practices concerning COVID-19 can play a significant role under the circumstance. Knowledge regarding the disease refers to the belief of an individual about the symptoms, treatments, causes, and prevention of the disease (8). While knowledge may control diseases and save lives (9), in many cases, wrong knowledge or misconceptions may endanger the lives of people. Attitudes are also important in handling diseases as positive attitudes make relaxation among people while negative attitudes create anxiety, depression, insomnia, and irritability (10). Practices, on the other hand, are built on knowledge and attitudes ought to be evaluated during pandemics as this will enable policymakers to find out the real scenario during the COVID-19 pandemic (11).

It is evident that the study of knowledge, attitude, and practices concerning the disease among at-risk populations is useful to prevent, control, and mitigate infections during epidemics (5, 12). Most of the existing literature shows the scenario of different communities from the general population, but there is very limited knowledge on the patients with chronic illnesses despite their high vulnerability to COVID-19 (6). Considering this knowledge gap, the main aim of the present study was to identify the knowledge, attitude, and practices concerning COVID-19 among patients with chronic illnesses in Bangladesh through a qualitative study. The findings of this study will help to formulate and revise, and policies concerning interventions aimed at reducing transmission, spread, and contracting COVID-19.

ANALYTICAL FRAMEWORK

For analyzing the knowledge, attitudes, and practices of patients with chronic illnesses regarding COVID-19 in Bangladesh, we used the knowledge, attitudes, and practices (KAP) model in our study. The theory was first introduced in the 1960's to explain human health change behavior (13). The model has been classified into three consecutive processes, i.e., knowledge, general attitudes, and adoption (practices) of behaviors called KAP theory. According to this theory, there is a progressive relationship among knowledge, attitudes, and behavior as follows: knowledge is the foundation of behavioral change, while belief and attitudes are the driving force of behavioral change. The basic presumption is that one's health promotion

and effective illness management are linked with KAP level. On the other hand, poor health and maladaptive disease preventive behavior are associated with KAP deficiency (14). This way we assume that the knowledge, attitudes, and practices of patients with chronic illnesses concerning COVID-19 can effectively increase or decrease their awareness, positive attitudes, and behaviors influencing the disease outcome. We, therefore, took KAP as the analytical model considering its relevance to the assessment of the knowledge, attitudes, and practices of patients with chronic illnesses concerning COVID-19 in Bangladesh.

METHODS AND MATERIALS

We conducted a qualitative study focusing on the narrative of patients with pre-existing chronic illnesses to bring out rich information on the topic of our study (15). The research was performed in Khulna city of Bangladesh from May 2020 to September 2020. Given the risks of contacting COVID-19 with face-to-face interviews, we chose telephone interviews to collect data from our participants. Instead of population statistics, our sampling involved the particularly vulnerable group of patients with chronic illnesses during the pandemic as we selected the respondents purposively. The contact details of the participants were collected from the registration records of different clinics and health centers. We called the patients with chronic illnesses who visited medical practitioners in those clinics and health centers previously over the phone and briefed them about our research initially. Those who agreed to participate in our study were contacted further for data collection.

We interviewed a total of 40 patients with four types of common chronic illnesses (diabetes, hypertension, asthma, and heart disease). Ten participants with each of these chronic illnesses were selected for interviews in this study. We used a semi-structured interview guide developed through a rigorous analysis of the previous literature on similar topics. Starting from the age of 18, we included patients from each of the four chronic illness categories where respondents of different ages, sex, religion, residence, marital status, and social classes participated to ensure maximum diversification of information (**Table 1**). While conducting qualitative research, telephone interviews can often be difficult to bring out narrative data. So we employed effective strategies based on lessons learned from previous studies that followed the same technique (16, 17). We cultivated rapport, maintained regular connection, incorporated concerns, and acknowledged the contribution of our participants to ensure maximum effort and overcome the adversities that might limit the scope of this study during the 4-month of data collection. The duration of each interview varied based on the convenience of the respondents and the data collectors through an average session would last between 30 and 40 min. As it is often difficult to take the interview over the phone for a very long time and to enter into a deep conversation within a very short time, we carefully maneuvered this issue throughout data collection. Potential inquisitive questions and probes were used for further understanding of the reality experienced by the participants. We included a set of questions for our interviews

TABLE 1 | Sociodemographic profile of the participants.

Sl.	Name*	Age	Sex	Marital status	Education	Residence	Social class	Illness type
1	Shamim	52	M	Married	Tertiary	Urban	Upper	Diabetic
2	Rina	55	F	Married	Secondary	Urban	Lower	Heart
3	Sumon	32	M	Unmarried	Primary	Rural	Middle	Diabetic
4	Taher	45	M	Married	Secondary	Urban	Lower	Hypertension
5	Asha	29	F	Unmarried	Secondary	Urban	Upper	Asthma
6	Mitu	33	F	Unmarried	Illiterate	Rural	Lower	Hypertension
7	Shirina	45	F	Married	Primary	Rural	Middle	Diabetic
8	Shila	26	F	Unmarried	Tertiary	Urban	Upper	Heart
9	Rayhan	28	M	Unmarried	Secondary	Urban	Middle	Asthma
10	Alam	65	M	Married	Primary	Rural	Lower	Hypertension
11	Sabbir	56	M	Married	Primary	Urban	Middle	Heart
12	Naima	60	F	Married	Primary	Rural	Lower	Heart
13	Shawon	25	F	Unmarried	Secondary	Urban	Upper	Asthma
14	Kawsar	40	M	Married	Secondary	Urban	Upper	Diabetic
15	Titu	70	M	Married	Illiterate	Rural	Middle	Hypertension
16	Mila	56	F	Married	Primary	Rural	Lower	Asthma
17	Ariyan	29	M	Unmarried	Tertiary	Urban	Upper	Hypertension
18	Munni	45	F	Married	Primary	Rural	Middle	Diabetic
19	Kulsum	25	F	Unmarried	Tertiary	Urban	Upper	Heart
20	Shahajul	66	M	Married	Secondary	Urban	Middle	Diabetic
21	Shamim	26	M	Unmarried	Primary	Rural	Middle	Diabetic
22	Jamal	55	M	Married	Secondary	Urban	Middle	Heart
23	Soheli	60	F	Married	Primary	Rural	Lower	Hypertension
24	Sarif	25	M	Unmarried	Secondary	Urban	Middle	Hypertension
25	Jahir	29	F	Unmarried	Tertiary	Urban	Upper	Asthma
26	Jony	31	M	Married	Illiterate	Rural	Lower	Asthma
27	Shirina	45	F	Married	Illiterate	Rural	Middle	Diabetic
28	Safikul	26	M	Unmarried	Secondary	Urban	Middle	Heart
29	Rani	28	F	Unmarried	Secondary	Urban	Upper	Asthma
30	Atahar	65	M	Married	Illiterate	Rural	Lower	Hypertension
31	Shiuli	33	F	Unmarried	Primary	Urban	Middle	Heart
32	Azhar	60	M	Married	Illiterate	Rural	Middle	Heart
33	Firoz	25	M	Unmarried	Secondary	Urban	Upper	Asthma
34	Munni	40	F	Married	Tertiary	Urban	Middle	Diabetic
35	Rafiul	35	M	Unmarried	Primary	Rural	Middle	Hypertension
36	Moni	56	F	Married	Secondary	Rural	Upper	Asthma
37	Jafar	29	M	Unmarried	Secondary	Urban	Upper	Diabetic
38	Munni	45	F	Married	Primary	Rural	Middle	Heart
39	Kulsum	25	F	Unmarried	Tertiary	Urban	Middle	Asthma
40	Selim	66	M	Married	Secondary	Rural	Upper	Hypertension

Identities used in this table are pseudonyms.

in this study and provided this as **Supplementary Material** along with this manuscript. Authors, SRR, NAN, and MFR, conducted the interviews and collected data through multiple sessions and with the convenience of the participants.

Data Analysis

All the data collected were recorded in information sheets, and audio has taped simultaneously for analyses. The transcribed data were coded and subsequently categorized for thematic analysis. SRR and NAN independently coded the data from the transcript developing a code structure initially, which was later finalized with the consent of the other authors. Level of knowledge, the pattern of attitude, and practices of the participants were measured focusing on accuracy, meaning, phrase, context, clause or concept, and frequency and intensity of comments as we ranked them into high/positive, moderate, and low/negative, categories for reference. Apart from using a qualitative data analysis software QDA Miner, we went

through the records line-by-line as well. We selected the most important and repetitive quotes to represent the selected themes as five overarching themes emerged from our analyses—level of knowledge, sources of information, attitude and beliefs, hygiene practices and the use of protective equipment, and social distancing.

Ethical Considerations

We maintained strict ethical standards for conducting this study. We took informed consent from the participants before data collection as they were briefed about the subject matter of the study. The participants were assured that all the information they have provided will be kept confidential and that their responses will be used only for academic purposes. We used pseudonyms to keep the anonymity of all the participants in our study. We also obtained approval from the Ethical Clearance Committee of Khulna University for conducting this study.

RESULTS

Level of Knowledge

We found that the level of knowledge among people about COVID-19 was moderate in our study. However, literate participants had sophisticated knowledge about COVID-19 as they had access to different sources, such as television, radio, and the internet. On the other hand, people who did not have sufficient education or had no access to media developed their knowledge from their surroundings, such as friends, family, or other contacts.

One of the participants with asthma with relatively higher education expressed, *"COVID- 19 is not a serious disease. We may control this virus by following the instructions of the government. Nevertheless, I have known that high temperature can kill the COVID-19 virus though I'm confused about it. There is mixed literature about the link between temperature and the spread. I hope, the outbreak of this virus will decrease after the availability of the Corona vaccine as most of the countries are not going for herd immunity."*

Such statements imply a sophisticated knowledge of participants with higher education under the context although not all participants had so that much knowledge regarding the disease. We also observed that COVID-19 was regarded as a major threat at the beginning of the pandemic, but as time passed, the fear of COVID-19 decreased significantly. By the end of our data collection period, most of the participants were not worried about the disease anymore and were ready to deal with the implications of the pandemic.

Another male participant with diabetes stated that *"I am not worried at all! Coronavirus is a serious disease. but not everyone dies from it. Since COVID-19 is transmitted through respiratory droplets, maintain social distances and wearing protective equipment can help us prevent the spread of this disease."*

However, there were also misconceptions about the virus and its remedies. Though participants from an urban background, with a higher level of education and upper social class, had good knowledge about the disease and those who have not adequate

education, lived in rural areas and from lower social class had a certain misunderstanding about the disease.

One of the participants with hypertension and a low-level education stated, *"Why should I bother about coronavirus! The medicine (vaccine) is available now. Now we should go back to our normal life."* Another participant with heart disease expressed, *"I have seen different types of information in the social media. While some say the disease has symptoms, the others say it doesn't have any. Some people are saying high temperature kills the virus, while others nullified it. It's difficult to understand what is right and what is wrong these days."* These participants highlighted the difficulties of "understanding" the risk factors for COVID-19 and optimal strategies for preventing transmission due to the confusing and often mixed messages they received from different information sources.

Sources of Information

Under the lockdown situation, most of the participants with a higher level of education and higher social classes informed that they would stay indoors and gathered information regarding COVID-19 from various sources, such as national and international dailies, TV channels, and the internet.

One of our participants shared, *"One day I was listening to the news on television. I suddenly got informed about COVID-19 then I asked my friends about it. Gradually I developed some knowledge about it."*

However, sources varied for people from different backgrounds. When we asked a female garment worker with a hypertension condition, the 33-year-old replied, *"I do not have time to watch television. I heard of it for the first time when my fellow workers shared this news (COVID-19) sharing the news about COVID-19. I remember our manager ordered us to maintain social distancing and ordered that we should wash our hands frequently and we must have to use a face mask while working in the industry."*

The source of knowledge for the participants also differed based on geography. Participants who lived in city areas had access to the internet while participants who lived in rural areas did not have that. One of our participants from the city area shared, *"I came to know about COVID-19 from Facebook first. At first, I did not realize that it was that fatal and contagious. But after some time, I came to know about further details that it is so far the most contagious disease where the death rate is not very alarming but the rate of infection is very much shocking."*

Attitudes and Beliefs

Although a large number of people in Bangladesh have a low level of education and awareness regarding health matters, to our surprise, we observed that overall, the participants had a positive attitude toward COVID-19 in general. For example, they were supportive to people who contracted the disease or would not generally stigmatize someone for being COVID-19 positive at this stage. This may be due to various factors, such as widespread media circulation and awareness programs from the government during the pandemic.

A female participant with hypertension explained, *"People need to be more supportive during the lockdowns. Mental health*

is equally important as it affects our immunity system. I am ready to help to maintain social distancing." While another male participant with asthma from a rural background opined, *"Although COVID-19 is a contagious disease, a patient infected with it cannot be blamed. We should work together and support him/her during this distress."*

However, things were not the same in the initial phase of the pandemic, when people were obviously frightened and were unwilling to take the risk of contracting COVID-19. As months passed, they started to accept the risk of contracting COVID-19, partly to enable "normal" functioning in life and partly because of their perceptions of low mortality risks associated with COVID-19. Even there is still some prejudice against diseases, such as HIV, jaundice, cholera, malaria, and typhoid, in Bangladesh as some people consider these diseases as a curse. They often explain the epidemics and infectious diseases from their own supernatural beliefs. Such explanations are more common in rural areas.

There was also a religious element to the perceived risks of contracting COVID-19, which seemed to also be linked to participants with lower education and in lower social classes, *"Real Muslims are not affected by COVID-19. Because they perform ablution during the five daily prayers according to Islamic law. The persons who strictly follow the rules of Islam, can't be affected by this virus."* Another respondent expressed similarly, *"I think it is a course from God because of our wrong deeds. When the amount of evil deeds increases, such wraths from Allah is inevitable."* Participants who believed that COVID-19 would not affect "real Muslims" and was an act of God would be less likely to adhere to Government guidelines about social distancing, social isolation, and other risk mitigation strategies.

Hygiene Practices and the Use of Protective Equipment

Proper hygiene practices are extremely important to control the transmission of COVID-19. However, our participants reported that they followed hygiene practices concerning COVID-19 strictly initially when the pandemic started. As time passed, they started to care less and were less rigid in following practices, such as frequent hand-washing or using sanitizers regularly. This scenario was more common among participants from rural areas. *One* of our respondents from rural background said, *"is extremely difficult to follow each instruction they (government) give. I don't think it's that much necessary to cleanse my hands with sanitizer every single time I touch any object."*

Aside from following these practices, the use of protective equipment is strongly recommended to keep COVID-19 away. Some participants also reported that though they had the willingness to buy sanitizers, masks, and gloves for protection but they could not pay for them. One of our male participants with diabetes mentioned, *"Sanitizer companies have raised the price of sanitizers and hand-wash products. A one-time mask costs 20 takas (Bangladeshi currency) these days. Is it logical to spare 20 takas for a one-time usable mask? I am not going to do it."*

Many participants expressed that they were unwilling to use protective equipment due to lack of willingness and discomfort. One of our participants with asthma condition narrated, *"I think it's impossible to wear a mask all the time. Many of these are cheap in quality and the premium ones block so much air that it makes it difficult for me to breathe properly. That's why I have decided to wear a mask only when it's an emergency."*

A few participants, however, expressed that they are cautious about hygiene maintenance and wearing protective equipment due to their previous experiences. *"I became seriously ill when I had this coronavirus a few weeks back. Since then, I use mask whenever I go outside and avoid touching my eyes, nose, and mouth. I try to cover my nose and mouth with a tissue whenever coughing or sneezing and throw the tissue in the trash after using it. At the same time, frequently I wash my hands with hand sanitizer and soaps. I am trying to pay more attention to my hygiene than usual as I know I am weak (immunocompromised)."*

Most of our participants shared that they have become less interested in taking nutritious foods or vitamin supplements to keep themselves healthy as days passed during the pandemic. They would not exercise or monitor their health regularly although the scenario was quite different at the beginning.

Social Distancing

The WHO recommends the social distancing of 1 m from one person to another to prevent transmission of the COVID-19 (18). This is why countries have imposed nationwide lockdowns and closed many institutions to avoid public gatherings. From our study, it was revealed that almost all the participants had some knowledge about social distancing, but none would follow the instructions. The reason they mentioned was either obligation or unwillingness as one of our young male participants with hypertension condition shared, *"I have to go to my factory every day. Otherwise, I will lose my job. I know that everyone should keep some distance from one another, but it is quite impossible for me because I have to use public transport each day. No one is following social distancing in this country. Why should and how can I do that alone!"*

Most of the participants agreed to this statement that maintaining social distances was almost impossible for them when a majority in the society is careless about it as narrated by one of our respondents with heart disease, *"I don't think it is possible to maintain social distancing in the country. Look at this huge population! Most of them are unwilling to stay home for a long time. It is impossible to stay home for a long time."*

Some also pointed the inability of the government to maintain social distancing, as a participant opined, *"The government failed to implement social distancing. You cannot make things work this way. Look at these poor people. They have many dependents in their family and our government simply cannot provide them with daily necessities for even 1 month."* Another female participant with diabetes expressed her concern saying, *"I have been living in fear of contracting COVID-19 these days. Though I am staying home, the other members of my family are frequently visiting outdoors. People do not even care about social distancing these days. Who knows what they (family members) are bringing home!"*

DISCUSSION

The objective of this study was to investigate the knowledge, attitude, and practice concerning COVID-19 among the patients with chronic illnesses in Bangladesh. To the best of our knowledge, this is the very first qualitative study using KAP theory in the country, and one of the very few over the globe. While conducting this study, we tried to get the most detailed information from patients with chronic illnesses regarding their experiences, beliefs, and concerns during the pandemic. Corresponding to some of the existing literature, we observed that most of the participants had a moderate level of knowledge about the transmission, symptoms, and prevention of COVID-19 (19–22). Even though the participants had decent knowledge about COVID-19, they practiced less in accordance with their knowledge level. Besides, although the attitude toward COVID-19 was positive in general, misconceptions regarding the disease were also reported by some participants. However, contrary to our findings, some other studies have reported positive attitudes and good practices concerning COVID-19 (18–22).

We found that patients with chronic asthma and heart disease were generally more concerned about COVID-19 compared to the other risk groups in our study. This might be due to the fear of the increased risk of severity for heart and lung conditions (23). Besides, almost all the participants in our study faced treatment difficulties during the COVID-19 period as many doctors would not visit patients during the pandemic. While epidemic outbreaks can cause psychological trauma and negative emotions, such as fear, anxiety, and helplessness, the unavailability of doctors during the COVID-19 pandemic affected the mental state of patients with chronic illnesses (5, 24). We noted that all the participants in our study were more careful about their health during the initial COVID period than pre-COVID time. As time passed, the majority of the respondents started practicing safety behaviors less and would rarely wash their hands with soap or sanitizer. After a few months of the inception of the pandemic, touching face with unwashed hands, shaking, moving outside became very common (6). To maintain risk mitigation behaviors, more regular Government mass-media messaging may be required.

Previous studies also mentioned that to control infectious diseases such as the H1N1 flu outbreak, the assessment of the knowledge, attitude, and practice of people has played a significant role (8, 25–27). Knowledge, attitudes, and practices regarding COVID-19 among the patients with chronic illnesses might play an important role to combat the transmission, especially in countries, such as Bangladesh, where health facilities are poor (1, 28).

The KAP theory suggests that knowledge of people is often derived from their education. Corresponding to this theory, we also observed that the education and knowledge of our participants are interrelated (22). We found that participants with higher social status and living in urban areas had higher knowledge levels and followed the safety instructions recommended by the Ministry of Health and Family Welfare of Bangladesh and WHO more accurately than the others. Around two-thirds of the total population in Bangladesh live in rural areas while most of them are poor (2, 24). While these people had some basic knowledge, they were often unwilling to practice the health instructions properly due to work-related and financial reasons (6). Besides financial issues, we also recorded that religion was linked with knowledge, attitude, and practices concerning COVID-19. We observed that many orthodox followers of Islam were unwilling to practice social distancing and believed that the COVID-19 pandemic is a curse from God and will not affect the believers (15). Research is required to understand if this is similar in other predominantly Muslim countries, and indeed, in other orthodox followers of other religions around the world. Targeted public health information is required to work with religious communities to reduce the risks of transmission of COVID-19.

Knowledge, attitude, and practices of people concerning any health behavior are largely dependent on their sources of information. In line with some existing literature, our study showed that the majority of the participants with a higher level of educated obtained information regarding COVID-19 from mass media such as television, radio, and the internet (6, 15, 19, 22, 29). It is interesting that, more than surrounding people like friends and family or healthcare professionals, mass media played a more important role in spreading awareness on COVID-19 and helped to curb the transmission of the disease (30, 31). In contrast, the participants with low education have reported learning about the virus mostly from people around them (29, 31). We found a majority of the participants to hold an optimistic attitude toward COVID-19 patients and expressed positive ideas to overcome the pandemic in line with some of the previous research (20, 22). We also observed that safe practices were significantly higher among the women, married, educated, and those who live in urban areas (6, 19) while safety practices and use of protective equipment were less common among the unmarried, illiterate, and rural men (19, 22).

STRENGTHS AND LIMITATIONS

We acknowledge that our study has certain limitations as we had to conduct the research during the pandemic situation. It was not possible for us to collect data through face-to-face interviews during the series of nationwide lockdowns. We also admit that it is difficult to conduct research using this technique. However, we employed effective interviewing strategies, such as maintenance of regular contacts and recording concerns of the interviewees, over a significant time to overcome the odds. Besides, there may be questions regarding the simplification of results with a few numbers of participants, but we strengthened the rigor of information by the quality of the data in our study. The main strength of this study, however, was its novelty that we employed KAP theory from the qualitative perspective in Bangladesh for the first time in this study. We believe that the findings of this study can provide important insights for policymakers to formulate and improvise awareness programs and strategies to manage the pandemic or similar events in the future.

CONCLUSION

Patients with chronic illnesses in Bangladesh have become vulnerable during the COVID-19 pandemic. The findings of this study revealed that the patients with chronic illnesses had moderate knowledge and a positive attitude toward COVID-19, but their safety practices were weak. Although the government has already taken several steps to mitigate the spread of the diseases, it has been difficult to ensure proper safety practices due to different socioeconomic issues. Applying the KAP theory, we tried to how the participants' knowledge, attitude, and practices depend on their level of awareness. Owing to these facts, health education programs and policy interventions are necessary to ensure the health and well-being of patients with chronic illnesses right now. Under this circumstance, the above findings have some important policy implications. First, awareness programs on mass media should be emphasized more under the lockdown situation. Second, specialized and emergency medical services should be ensured for the patients with chronic illnesses. Third, the government needs to impose safety practices more strictly. Special subsidies on hygiene products and personal protective equipment can be provided to make it more available for people. Finally, we suggest that patients with chronic illnesses be prioritized when the vaccines are available. Preferably, it should be provided free of charge to the vulnerable groups who are at high risk at present. While implications of this study will help policymakers and researchers, we recommend further research on this topic to get a comprehensive idea of the knowledge, attitude, and practices concerning COVID-19 in Bangladesh.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/**Supplementary Material**, further inquiries can be directed to the corresponding author.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Ethical Clearance Committee, Khulna University. Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpubh.2021.628623/full#supplementary-material

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Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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The Analytical Framework of Governance in Health Policies in the Face of Health Emergencies: A Systematic Review

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The Governance Analytical Framework (MAG) defines governance as a social fact, endowed with analyzable and interpretable characteristics, through what it calls observable constitutive elements of governance: the problem, the actors, the social norms, the process of decision-making and scope or nodal points; in the sense that each society develops its modes of governance, its decision-making or conflict resolution systems among its members, its norms, and institutions. In this perspective, the purpose of this article was to carry out a systematic review of the scientific literature to understand the role of governance in health policies in health emergencies, such as that caused by the SARS-CoV-2. The systematic review was designed based on the methodology proposed in the PRISMA (Preferred Reporting Items for Systematic Review and Meta-Analysis) Declaration. The literature search was carried out in six databases: Psychology and Behavioral Sciences, APA-PsycInfo, MEDLINE, eBook Collection (EBSCOhost), PubMED, and MedicLatina, published in the last 5 years. Fifteen articles that met quality and evidence criteria were analyzed. The governance approach alluding to the health emergency problem in health policies was the most addressed by the authors (80%), followed by a description of the actors (40%), the process of decision-making spaces (33%), and ultimately, social norms or rules with 13%. Formulating a coherent set of global health policies within a large-scale global governance framework is mostly absent. Although the countries adopt international approaches, it is a process differentiated by the social, economic, and political contexts between countries, affecting heterogeneous health outcomes over the pandemic.

Keywords: governance, health policy, pandemic (COVID-19), public policy, government

INTRODUCTION

Health systems worldwide have faced several challenges in meeting one of their primary objectives: service delivery. Regardless of the type of system, structure, organization, and its level of income, one of the shared challenges is related to leadership and governance (1); which refers to the governmental role in public health and its relations with the actors responsible for

population health, through the development of strategic policies that respond to the expectations of the environment.

Governance focuses on decision-making and the potential of its actors to subvert national (or international) policy at the local level (2). In this regard, it is essential to understand the process of developing and implementing health policies to address global health emergencies such as the current SARS-CoV-2 pandemic, to generate evidence that serves as the basis for the knowledge of decision-making in the health system's response to face the emergency.

As a generalizable concept, governance refers here to a kind of social facts, formal and informal collective decision-making processes, and the elaboration of social norms concerning public affairs (3). Addressing governance in public health demands to have a delimited, observable, reproducible, and generalizable object. The Governance Analytical Framework (GAF) defines governance as a social fact, endowed with analyzable and interpretable characteristics, through what it calls observable constitutive elements of governance: the problem, the actors, the social norms, the process, and the nodal points (3), in the sense that each society develops its modes of governance, its decision-making or conflict resolution systems among its members, its norms and institutions.

In the present case, to contain the current health emergency, various measures recommended by international organizations have been issued (4), which have adverse effect implications in the different sectors of the population's social and economic development. Besides, governments worldwide have implemented countless health policies in response to the COVID-19 pandemic (5), strategies that require a consensus among decision-makers in health policies. The analysis of the processes of development and implementation of health policies in the face of the current health emergency, from different government levels, will generate substantial evidence in the knowledge of decision-making and how they affect responsibility in health care (6).

However, to date, policymakers have not had access to quality data; it is unknown to what extent implemented policies have mitigated the pandemic and its effects on health outcomes and economic effects (5).

In this perspective, this article's purpose was to conduct a systematic review of the scientific literature to find out what the role of governance has been in health policies in the face of international health emergencies, such as that caused by the SARS-CoV-2 virus.

METHODS

We developed a systematic review and analysis of the international literature published in the last 5 years on the role of governance in health policies addressing health emergencies and specifically in the face of the COVID-19 pandemic.

The literature search period covered from January 1, 2015, to June 30, 2020. The systematic review was designed based on the methodology proposed in the PRISMA Statement (Preferred Reporting Items for Systematic Reviews and Meta-Analyses).

The search of the scientific literature was conducted between April to June 2020 and was carried out in six databases: Psychology and Behavioral Sciences Collection, APA PsycInfo, MEDLINE Complete, eBook Collection (EBSCOhost), PubMED, and MedicLatina. Gray literature was not included.

Following a preliminary review of various terms in the literature and definition of MeSH terms in the databases, the keywords were selected to identify articles relevant to scientists in health policy governance research facing health emergencies and SARS-CoV-2. The search was carried out for 23 combinations of the following descriptors: (1) "governance" or "government"; (2) "health systems" or "organizational policy" or "public policy" or "policy" or "health policy" or "policy-making," and (3) "SARS virus" or "pandemic." The descriptor combinations that yielded results are shown in **Figure 1**.

A total of 578 items were obtained. In the exploration of search terms in the database that include Spanish-language publications, no articles were found.

When narrowing down the search for the terms mentioned in the title and abstract, 222 articles were obtained; in this first filtering, 95 documents were suppressed because duplicates were found.

Titles, summaries, and a full first reading of the 127 articles were examined for content review, under the following inclusion and exclusion criteria:

Inclusion Criteria

Relevant articles according to our study purpose and level of analysis: (i) approximation to the term of governance in the problem of health policies in the face of health emergencies and SARS-CoV-2; (ii) process and decision-making spaces for health emergencies and SARS-CoV-2; (iii) actors involved in the decision-making; (iv) rules that were adopted for the decision. According to their type, the articles included were research articles, original articles, short research articles, special section, review articles, case studies, author's manuscripts, and journalistic articles.

Exclusion Criteria

Letters to the editor, news, comments and case report, incomplete articles, and articles that did not include in their approach the study objective of this review were excluded. A total of 42 articles were obtained for an exhaustive, detailed, and critical reading. A checklist was applied according to the Scottish Intercollegiate Guidelines Network (SIGN) adapted form, which assessed the quality and evidence criteria, according to following: (a) sufficient evidence to answer the objective; (b) consistent studies with their conclusions; (c) relevant studies for our objective (similar subject matter); (d) concern about publication bias (origin of studies, groups of researchers, organizations); (e) proposed benefits; (f) feasibility, if the study is applied to the context; (g) recommendations, evidence-based development, and future research. Fifteen articles were excluded for not meeting the proposed quality criteria. Furthermore, seven articles were excluded to be repeated in the PubMed and MEDLINE databases. Finally, 15 articles were included in the systematic analysis (**Figure 1**).

FIGURE 1 | Algorithm for searching the scientific literature of the systematic review.
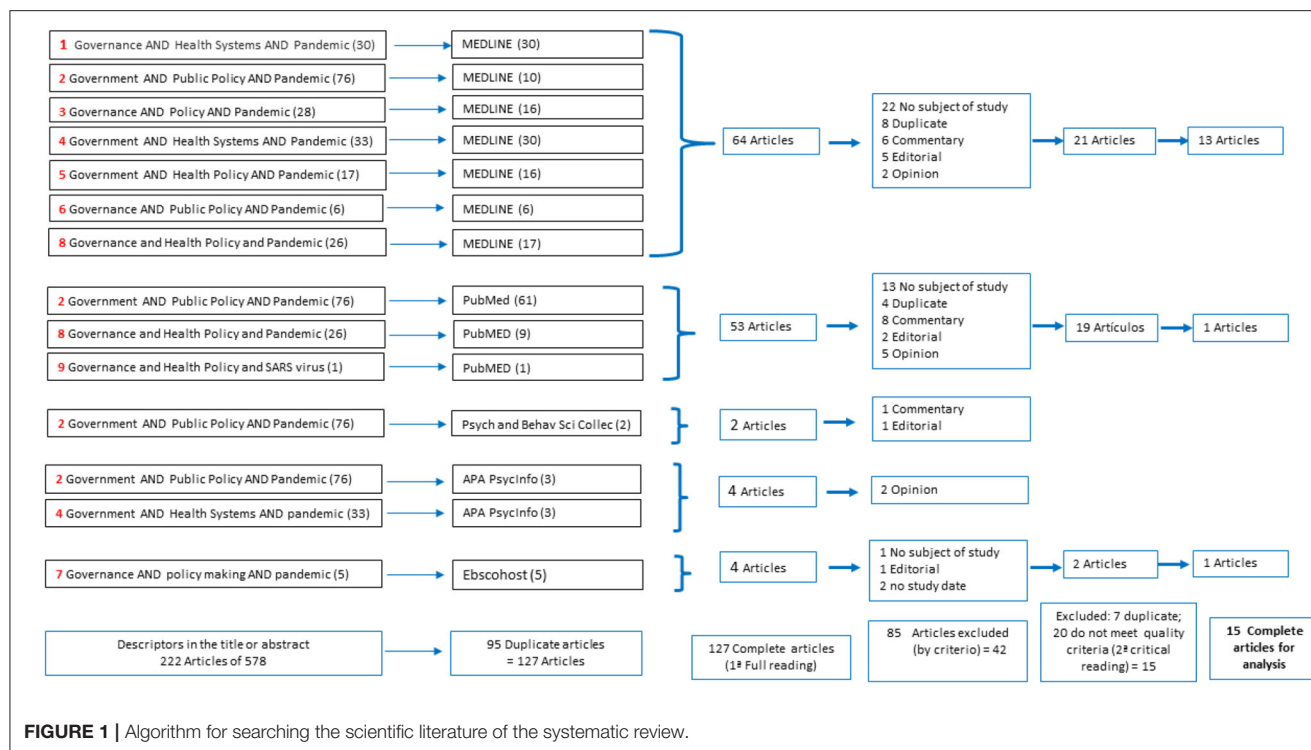
RESULTS

Most of the studies reviewed were conducted in the United Kingdom (UK), followed by Asian countries (China 20%, Iran 20%, and Indonesia 7%), from Latin American countries, studies were only reported in Brazil (**Table 1**). Eighty percentage of the articles were published in the first semester of 2020. Regarding the constituent elements of governance, the governance approach to allude to the problem of health emergency in health policies was the one most addressed by the authors (80%), followed by a description of the participating actors (40%), the process of decision-making and spaces (33%), and ultimately, they addressed social norms or rules of the game with 13% (**Table 1**).

Governance Approach in Health Policies in the Face of Health Emergencies

For a better understanding of the study, we divided our analysis of governance in health policies into three critical points identified in the review (**Table 1**).

Country-Level Coordination, Planning, and Monitoring

The studies under analysis demonstrate the national and international scope of the pandemic response (8, 11, 13) and cross-sectoral participation with multi-level representatives with the common goal of generating proactive responses aimed at creating resilient systems (8). The importance of local leadership, ethics, and values of cooperative society (8), incorporating strategies in a coordinated and collaborative manner and

integrating equity values (9), reciprocity, protection, self-care, co-responsibility, and solidarity, is underlined (8).

The most widely implemented health policies at the country level are health resources (5) and anti-contagion measures. Policy evaluation studies (12), decision-making process (17), strategic action, or policy design (7) were not identified.

Risk Communication and Community Engagement

In the management of the health emergency, first, it is considered (a) disclosure or control of information; (b) hazard and threat assessment; (c) establishment of crisis information communication channels and health education platforms; (d) the development and implementation of strategic response plans, and (e) general mobilization of critical resources (16).

A study evidenced a national public health emergency management system (19) and recommended increasing risk perception in the population, as it is a predictor of public protection measures (11). With this same approach, estimating risks in the design of government intervention policies is an associated strategy (15), pointing out that information control is the basis of health emergency management (16).

Surveillance and Rapid-Response Teams, and Case Investigation

Conceived as one of the essential functions of public health, the epidemiological surveillance policies (20) adopted by the member countries, follow the context, the preparation of health facilities, financing, health personnel, information and research, and medical products and technologies (4). Most governments have implemented policies in response to COVID-19 that are

TABLE 1 | Classification of the articles by governance analysis level on health policies in the face of the health emergencies.

Author/year		Connolly (7)	Khan et al. (8)	Plamondon and Pemberton (9)	Aquino et al. (10)	Cheng et al. (5)	Duan et al. (11)	Hsiang et al. (12)	Pan et al. (13)	Rai et al. (14)	Raoofi et al. (4)	Requia et al. (15)	Shangguan et al. (16)	Tabari et al. (17)	Taghrir et al. (18)	Xu and Yang (19)
							Chronology of authors									
Source (Journal)		Disaster Prev Manag	BMC Public Health	Health Res Pol Syst	Cien Saude Colet	Nat Hum Behav	Int J Environ Res Public Health	Nature	Microbes Infect	WHO South East Asia J Public Health	Arch Iran Med	Sci Total Environ	Int J Environ Res Public Health	Iran J Med Sci	Arch Iran Med	J Epidemiol Glob Health
Study Country/Region		UK	UK	UK	Brazil	UK	Chine	UK	UK	Indonesia	Iran	Brazil	Chine	Iran	Iran	Chine
Governance analysis level																
Country-level coordination, planning, and monitoring																
Effective communication			X				X	X	X							
Intersectoral participation			X			X	X							X		
Solidarity participation			X			X	X									
Equitable participation			X	X			X									
Responsible governance		X	X		X	X		X			X					
Risk communication																
Risk management							X					X	X			X
Surveillance and rapid-response																
Epidemiologic surveillance					X	X					X					
Actors who participate in health policies																
Multilevel		X	X				X			X						
Multisectoral			X	X						X	X					
Multidisciplinary			X													
Nodal points																
Decision making		X	X				X			X					X	
Scope			X							X						
Rules (or norms in decision making)																
Formal			X	X												
Informal			X	X												

The "X" signifies that article contains a category of analysis.

restrictions on external (border closure) and internal (school closure) mobility. The response involves various political and technical decisions; a study reported how limiting the response was based only on health services' capacity and not on a consensus to follow international recommendations (10).

The next element of governance under study refers to actors, involving two hierarchically and relationally in power dynamics (21).

Actors Involved in Health Policies in the Face of Health Emergencies

In the design and management of public health policies, a multi-level perspective is incorporated, this implies the participation of multiple actors (7) at the international level, such as the WHO and the Global Health Security Agenda (GHSA), actors in the government system, from the Federal Government, Municipal Governments, the Judiciary, the Legislative Branch, and the Ministry of Health; and Community actors (11, 14). Various interests of actors or groups seeking solutions converge in decision-making, even from their belief system (4). A study identified that those responsible for implementing, monitoring, and evaluating the response to the emergency (14) incorporated multisectoral coordination mechanisms, active participation of all stakeholders, and presidential support. Another successful study incorporated high-level decision-making, experts in preparing health emergencies (8). It was also documented that the lack of consensus among the different actors limits the effectiveness of the response (10).

Process of Decision-Making and Scope in Decision (Nodal Points)

Addressing the health emergency problem scenarios is complicated due to diverse interests in decision-making (7). Few studies document how the different actors participate, interrelated strategic levels of action in epidemic management and policy design (14). However, they demonstrate the international scope of responding to pandemics (8, 11, 22) at a high-level decision-makers and the need to assess all political decisions' success and failure to find the appropriate course of action in the high-level response (18).

The Rules of the Game (Normative, Formal, and Informal)

Finally, the WHO regulatory framework guides strategies; however, effective responses have documented the importance of local leadership, ethics and values, implying a set of formal and informal rules (8) in a coordinated, collaborative way and incorporating equity values (9). In other words, to make ethical decisions, it is necessary to include processes of inclusion, accountability, transparency, and responsiveness (8).

DISCUSSION

On January 30, 2020, the WHO Director-General declared the outbreak of the coronavirus disease 2019 (COVID-19) as a public health emergency of international importance under the International Health Regulations (23). On February 4, 2020, the WHO requested the United Nations crisis management policy's activation to establish a Crisis Management Team to help member countries to prepare for and respond to the emergency (23).

The Problem From Governance

The globally rapid spread of COVID-19 has created and exhibits a wide range of nuances and heterogeneity of health policies implemented by governments (24), making it difficult to assess them (25) to adopt it and hinders its recommendation, which shows the absence of a global governance framework (26). Despite this, most countries' governance approach follows the policies or measures suggested by the WHO (4) and the United Nations' strategic response and preparedness plan for COVID-19 (27). Countries like China and Canada have reported success in controlling the pandemic; however, in less developed nations, the persistence of health inequities has been a problem formed by the power systems themselves, in which competing social interests and values further increase these inequities (9).

The policies put into practice must be evaluated to address the response and solutions adopted to the pandemic. Nevertheless, in a study it is describe that the (international) response has been effective in containing the pandemic, it does not detail the decision-making process (17), nor monitoring activities (or indicators) for overall policy evaluation. Therefore, it is not possible to establish the extent to which the policy is effective or the scope achieved, or what information is required to measure that policy (28), and in any case, redesign it.

The Actors

Decisions in health policies in the face of health emergencies involve various actors, from the international scope, governmental at all levels, and community actors (11, 14). The particular interests of these actors converge on the political decision-making process. In fact, they can seek solutions based on their belief system; this phenomenon cannot be set aside in decisions, but an objective process must be included into the decision, for example, incorporating a coalition political system to achieve agreements between the participating actors and an evaluation on the implementation performance of the resulting policies (4). Therefore, to ensure that the policy's implementation is effective, it is essential to document the monitoring and evaluation of the response to the COVID-19 emergency (14), including all the multi-sector coordination mechanisms achieved among actors, as well as the active participation of all stakeholders (8). As documented, when agreements are partial or unilateral, the response's effectiveness is limited; in fact, the lack of consensus between the different actors leads to adverse health outcomes (10).

The Process of Decision-Making and Scope in Decision

The mechanisms and scopes of participation in the different strategic action levels related to epidemic management and policy design need to be made visible and documented (7), to adopt significant pandemic control recommendations. Beyond the

global stage, policy success lies in local capacity to subvert them. In this sense, there are differential effects between categories of government intervention and public adoption of measures in communities. In this scenario, it is recommended to increase the risk perception in the population, as government actions are related and predict public protection measures (11). An example of an associated government strategy is risk estimation in designing intervention policies (15).

On the other hand, dissemination and control of information in the health crisis are the basis in the design of management policies to face the emergency. Similarly, the scientific assessment of the emergency is necessary for the subsequent formulation of intervention policies; it must be based on accurate information; otherwise, the crisis can expand negatively (16). In this sense, the Chinese government published a success report, which has already established a national public health emergency management system (19).

Regarding the rules of the game (social rules), although international standards guide decisions in response to pandemics anywhere, to generate effective responses, local leadership, ethics, and social values are paramount, implying a game of formal and informal rules, including all society sectors (8) in a coordinated, collaborative way; it must also incorporate values like equity, reciprocity, trust, public protection, self-care, co-responsibility, and solidarity.

Therefore, the establishment of a global health governance framework that ensures equitable access for all to adequate health care in health emergencies should be in a prominent place on the global policy and legislative agenda. Though, the formulation of a coherent set of global health policies on a large scale is largely absent.

The literature discussed here was made in socially and economically developed nations, which have actors with some decision-making power (29) in international policies, as well as in the design of their indicators in the health system (30); but in those economically disadvantaged countries, with great social inequality, with a lower budget and health spending, with a weak structure of health systems (31), there are more significant disadvantages to adopting international recommendations to address pandemics. Another challenge for governance in these countries' health policies is that governments should consider local peculiarities, viability, sustainability, and potential risks and benefits before and after of public health policies implementation (32).

In this differentiated context of policies for protection and response to threats and vulnerabilities, from national and international guidelines, the necessity for countries to incorporate academics and civil society leaders at the local level is seen to integrate their perspective into the response to the health needs of the population (33). It is crucial to implement and document risk management policies, which implies the acquisition of an empirical response to an accelerated and rapidly changing dynamics of the COVID-19 pandemic.

A potential limitation to our analysis is the lack or scarcity of research on this topic, especially in less developed countries, thus, our findings may not include considerations from other countries not represented in the literature reviewed. On the other hand, we do not use gray literature, therefore, it is possible that we may have missed relevant information about the practice on governance in the health systems reported in this type of literature. Despite these limitations, we think that this study serves to demonstrate the need to increase the evidence on governance in health systems to face health emergencies.

CONCLUSIONS

This systematic review from a GAF approach allowed us to analyze governance challenges and its current state to subvert them from the international level to local scenarios in order to implement risk management policies. In future research, the GAF could be applied to identify and incorporate the analysis of other social actors with different levels of decision-making to respond to health emergencies. This could be documented to adapt them in different contexts.

AUTHOR CONTRIBUTIONS

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