PUBLIC HEALTH MATTERS: PANDEMIC, POLICIES, PROCESSES

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PUBLIC HEALTH MATTERS: PANDEMIC, POLICIES, PROCESSES

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Table of Contents

05 ***Editorial: Public Health Matters: Pandemic, Policies, Processes***
Noor Hazilah Abd Manaf, Yong Kang Cheah and Noor'ain Mohamad Yunus

07 ***The Populations' Resilience Toward the Policymaking Discrepancies in the Pandemic Covid-19 Period***
Hatem H. Alsaqqa

12 ***Inequalities in Knowledge About COVID-19 in the Kingdom of Saudi Arabia***
Omar Zayyan Alsharqi, Ameerah M. N. Qattan, Noor Alshareef, Gowokani Chijere Chirwa and Mohammed Khaled Al-Hanawi

22 ***Experience and Discussion: Safeguards for People With Disabilities During the COVID-19 Pandemic in China***
Fei Qi, Yuqi Wu and Qi Wang

34 ***A Cross-Sectional Survey on COVID-19 Vaccine Hesitancy Among Parents From Shandong vs. Zhejiang***
Yunyun Xu, Dongjuan Xu, Liyan Luo, Fengqiao Ma, Ping Wang, Hongfei Li, Qing Li, Lianyan Wei, Jiuzhou Diao, Yuanyuan Liu, Weiqiang Zhang and Xiaolei Zheng

42 ***Challenges and Approaches of the Global Governance of Public Health Under COVID-19***
Hu Zhang

52 ***Vaccine Confidence and Hesitancy at the Start of COVID-19 Vaccine Deployment in the UK: An Embedded Mixed-Methods Study***
Chrissy h. Roberts, Hannah Brindle, Nina T. Rogers, Rosalind M. Eggo, Luisa Enria and Shelley Lees

70 ***COVID-19 Testing in Sweden During 2020–Split Responsibilities and Multi-Level Challenges***
Mio Fredriksson and Anna Hallberg

87 ***The Impact of Strict Public Health Measures on COVID-19 Transmission in Developing Countries: The Case of Kuwait***
Abdullah A. Al-Shammari, Hamad Ali, Barrak Alahmad, Faisal H. Al-Refaei, Salman Al-Sabah, Mohammad H. Jamal, Abdullah Alshukry, Qais Al-Duwairi and Fahd Al-Mulla

96 ***Are We Better-Off? The Benefits and Costs of Australian COVID-19 Lockdown***
Anton Pak, Oyelola A. Adegboye and Emma S. McBryde

100 ***Learning From Each Other in the Management of Natural Disaster and COVID-19 Pandemic: A Case Study in Taiwan***
Hsiao-Wen Wang, Guan-Wei Chen, Wei-Lin Lee, Shuei-Huei You, Chia-Wen Li, Jiun-Huei Jang and Chjeng-Lun Shieh

112 ***Engaging Religious Institutions and Faith-Based Communities in Public Health Initiatives: A Case Study of the Romanian Orthodox Church During the COVID-19 Pandemic***
Stefan Dascalu, Patrik G. Flammer, Mahan Ghafari, Shaun C. Henson, Roger Nascimento and Michael B. Bonsall

121 ***Socio-Demographic Characteristics of COVID-19 Vaccine Recipients in Kwara State, North Central Nigeria***
Ahmad Ibrahim Al-Mustapha, Musa Imam Abubakar, Muftau Oyewo, Rita Enyam Esighetti, Oluwaseun Adeolu Ogundijo, Lukman Dele Bolanle, Oluwatosin Enoch Fakayode, Abdullateef Saliman Olugbon, Michael Oguntoye and Nusirat Elelu

127 ***Changes in Alcohol Consumption and Determinants of Excessive Drinking During the COVID-19 Lockdown in the Slovak Republic***
Beata Gavurova, Samer Khouri, Viera Ivankova and Matus Kubak

139 ***Public Confidence in COVID-19 Prevention and Response in Bangladesh***
Edris Alam, Kazi Abdur Rahman and Al-Ekram Elahee Hridoy

148 ***Impact of Safety Nets on Household Coping Mechanisms for COVID-19 Pandemic in Malawi***
Martha Mnyanga, Gowokani Chijere Chirwa and Spy Munthali

158 ***Assessing the Spatiotemporal Spread Pattern of the COVID-19 Pandemic in Malaysia***
Yoon Ling Cheong, Sumarni Mohd Ghazali, Mohd Khairuddin bin Che Ibrahim, Chee Cheong Kee, Nuur Hafizah Md Iderus, Qistina binti Ruslan, Balvinder Singh Gill, Florence Chi Hiong Lee and Kuang Hock Lim

169 ***What "Family Affair?" Domestic Violence Awareness in China***
Zhaohui Su, Dean McDonnell, Ali Cheshmehzangi, Junaid Ahmad, Hengcai Chen, Sabina Šegalo and Yuyang Cai

178 ***Health Policy Development During COVID-19 in Saudi Arabia: Mixed Methods Analysis***
Wadi B. Alonazi and Eman A. Altuwaijri

186 ***Inclusivity of Persons With Disabilities in the Work Sector During the Covid-19 Pandemic in Indonesia***
Dumilah Ayuningtyas, Niken Sasanti Ardi, Sandra Barinda, Ayudina Larasanti, Theresa Napitupulu, Cindy Margaretha and Sahfira Ulfa Hasibuan

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EDITORIAL
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Editorial: Public Health Matters: Pandemic, Policies, Processes

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Editorial on the Research Topic

Public Health Matters: Pandemic, Policies, Processes

COVID-19 has shown that governments and public health are intertwined. The decisions and actions of one bear consequence on the other. Never has the role of government been more significant in public health than in this pandemic. Government policies directed toward controlling COVID-19 brought to fore the significance of public health, and they are not only on the health of the population, but on the wider socio-economic repercussions to the society. The governments mandated lockdowns shuttered businesses, resulting in massive job losses and ability of people to work. School closures, transportation restrictions and movement control, for instance, brought about other unintended economic and social consequences. Vaccine mandates touches more than just equity and access, but also on individual right and trust in the governments and the big pharma (Roberts et al.). Thereby, what is the right trajectory in pandemic management? Should governments opt for suppressive lockdowns or engage in individual compliance instead? Two years down the line, how did the policies and processes fare in managing COVID-19 and in extenuating its socio-economic fallout? This topic thus explores national policies and organizational processes in pandemic control and response across the globe, including China, Sweden, Kuwait, and Mali, as no countries were spared from the impacts of COVID-19.

A mathematical model developed by Al-Shammari et al. to study the impact of strict public health measures in Kuwait, such as closure of schools, government offices and non-essential businesses, and full full-border lockdown. The authors showed that these measures had a desirable effect on lowering the intensity of outbreak in the initial stage. Since Kuwait has a large number of migrant worker population living in cramped conditions making social distancing untenable, this further exacerbate transmission when a strict lockdown was implemented.

Saudi Arabia was proactive in its pandemic response, and was among the first few countries to close borders and shift formal education to online learning. Mixed method analysis by Alonazi and Altuwaijir supported the effectiveness of Saudi Arabia's COVID-19 containment policies, which were carried out through three domains: health guidelines, utilizing simulation such as, telehealth and telecommunication services, and ensuring continuity of services. Alsharqi et al., on the other hand, assessed inequalities in knowledge of COVID-19 in Saudi Arabia and found the existence of socioeconomic inequality in obtaining proper knowledge about the disease. Knowledge of COVID-19 was found to be more concentrated among the better educated and wealthier strata of the society, prompting the need for ensuring an effective dissemination of health information across social classes.

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Fear of the virus coupled with strict public health measures caused disruption in economies around the world. To offset the shock, many governments introduced financial interventions and other safety measures to cushion the economic impact of the pandemic. In Mali, the government introduced COVID-19 Urban Cash Intervention (CUCI). The impact of this intervention and other safety measures was analyzed by Mnyanga et al. The authors showed that the intervention had a positive impact on households given that households were less likely to reduce food consumption, and rely on savings.

Fredriksson and Hallberg conducted a qualitative study related to COVID-19 testing in Sweden. The authors claimed that the independent public agencies and self-governing municipalities played an important role in providing understanding of COVID-19 testing. Their findings showed that having a mass test for COVID-19 in the country was a new issue which involved with numerous national and regional key players. This study also highlighted the importance of multi-level governance in managing healthcare during the crisis of COVID-19.

A case study about management of natural disaster and COVID-19 pandemic in Taiwan has been conducted by Wang et al. The authors argued that management for natural disasters could be used as a guideline to improve management for communicable diseases, such as COVID-19. Several important findings were highlighted by the authors: (1) government needed more financial resources and training to control COVID-19 pandemic; (2) a more flexible emergency operation for COVID-19 was needed; and (3) risk governance should play a more important role in controlling the spread of COVID-19.

Using data of Shandong and Zhejiang, Xu et al. examined the effects of hesitancy and region on use of COVID-19 vaccines. The authors found that parents in Zhejiang were more likely to use COVID-19 vaccines than those in Shandong. Factors influencing the hesitancy of parents included parental attitudes toward childhood vaccines, behavior as well as safety and efficacy of vaccines. Therefore, the authors suggested that strategies directed toward increasing use of COVID-19 vaccines among adolescents in Zhejiang and Shandong should take into account these factors.

Gavurora et al. made use of data of Slovak Republic to investigate alcohol consumption among adults during COVID-19 lockdown. The determining factors of excessive alcohol consumption were the main focus of this study. The authors found that the majority of people reduced their intake of alcohol during COVID-19 lockdown. In addition, findings of this study showed that the likelihood of excessive drinking was higher among males, younger adults and smokers compared with others. As pointed out by the authors, effective and evidenced based intervention measures could be implemented.

Drawing from Malaysian data, Cheong et al. analyzed spatiotemporal variations in the COVID-19 pandemic. Daily cumulated cases of COVID-19 were used for analyses. The authors found that risk of spreading COVID-19 increased across West and East Malaysia. In particular, the state with the most spread of COVID-19 was Melaka, followed by Sabah. Findings of this study could serve as useful guideline for COVID-19 prevention.

An article from Indonesia described the elements that influenced the inclusion of disabled workers during pandemics. According to the article, workers with disabilities were more vulnerable, which had an impact on their level of acceptance and inclusion at work (Ayuningtyas et al.). Another study used a survey approach to analyse public trust in the government of Bangladesh (GoB) and the private sector concerning the COVID-19 pandemic risk management. Findings from the study demonstrated that the GoB failed to satisfy public satisfaction levels regarding the food delivery and financial support among low- and middle-income people. This was due to a lack of collaboration and coordination among government and stakeholders (Alam et al.). There was a study using a mixed-method approach to examine the perceptions and attitudes linked with COVID-19 vaccination acceptability in the United Kingdom. Individual behaviors and the transparency of the vaccine development process were identified to be determining factors of people's willingness to participate in the COVID-19 vaccination programs (Roberts et al.).

AUTHOR CONTRIBUTIONS

NA, YC, and NM drafted the editorial. YC revised and approved the final version. All authors contributed to the article and approved the submitted version.

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REVIEW
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The Populations' Resilience Toward the Policymaking Discrepancies in the Pandemic Covid-19 Period

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The world is in the midst of a crisis unlike any other in recent memory. COVID-19 is a pandemic that is urgent, global in scope, and has huge consequences. The policy sciences provide insights into unfolding trends, and this article uses the lessons of the literature to better understanding the policymaking shifts and population acceptability of COVID-19. The author attempts to investigate how policymakers' emotions and narratives affect policy decisions and form policymaker-population relationships. The author addresses policymaking processes, transitions, interpretations of policy responses, policy implementation through multilateral topics and evaluating policy progress and failure. Trust is linked to cultural norms, values, and faiths in policy literature, and it is seen as a component of key social and economic policy outcomes. The author ends by identifying understudied facets of policymaking that need to be addressed during pandemics.

Keywords: COVID-19, pandemic, policymaking, resilience, crisis, population, behavior

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BACKGROUND

Since the spread of infection is multifactorial, countries that are equipped with a multipronged strategy perform better in managing a pandemic like COVID-19. It is worth noting that policymaking is focused in part on empirical experience, which was problematic in the case of COVID-19. When COVID-19 first appeared in early 2020, little was understood about the virus, its disease dynamics, or its consequences. As a result of the lack of information about COVID-19, evidence may be confused.

Because of the peculiar existence of COVID-19, where facts were not visible, policymakers had the aptitude to misinterpret facts. Wearing masks, banning public meetings, closing academic institutions and public areas, national and international mobility limits, confinement and a variety of other policies were implemented with the aim of flattening the curve. Compelled to respond quickly to the unfolding disease situation, politicians in every country attempted to balance the introduction of containment policies. Lockdowns were generally well-received at the start of the pandemic, with the rhetoric around health, and in reality, tight confinement in COVID-19 was related to increased intention to fulfillment and trust in policymakers (1). With the pandemic spreading and populations becoming more focused and fatigued by the various steps taken originally into consideration by policymakers, the pandemic is becoming more exhausting.

As a result, there has been a lot of debate in every society about whether or not the policymaker's actions were acceptable. Despite the difficulty of enacting such legislation, lawmakers, and public health experts must persuade their citizens to change their behavior and respect future containment steps. As a result, it is important to take into account people's concerns about the pandemic and

their views of the repercussions of protection policies so that future policies and response planning are well-informed, and the public can expect a high level of compliance.

As a result, looking at the media will reveal how policymaking has changed over time. The public's growing fatigue with lockdowns aligns with this experience, as opposed to the population's initial positive response to "doing their part" to flatten the curve. The global shock caused by COVID-19 has shown how long-lasting the policy conclusions are. It seems that people are no longer willing to embrace the excuse that problems are too complicated or time-consuming to solve.

Individuals have the opportunity to present their positions in new venues in order to build allies and effect policy change. To summarize, the equilibrium can be punctured by trying to alter policymaking, expanding conflict, and venturing into new policy arenas. The public's acceptance of a program has an effect on its' chances of success (2). Although research has looked into the public acceptability of various frameworks for transmitting policy messages (3) there has been very little nationally representative public research into public acceptance of various health policies.

THE PUBLIC HEALTH POLICYMAKING PROCESS IN CRISIS

Advocates for population health must become more politically astute and pay more attention to health's political indicators. It is important to consider how the social science literature on policy reform can be incorporated into the public health strategy if population health policies are to be effectively developed and implemented (4). The nature of the issue, the scale of the benefits and adverse effects, viability and acceptability, as well as resource and equity implications, all must be carefully considered when making public health decisions.

In the absence of strong scientific evidence, politicians must adhere to basic values that can direct decision-making in order to guide public health best practices. These circumstances provide policymakers with challenges related to decision-making, public knowledge, sense-making, transparency, learning, and change (5), but they also necessitate broad cooperation and teamwork involving numerous individuals and organizations. During complex crises, resolving value differences can lead to public debates and blame games.

The recognition of the need for and application of "sophisticated scientific evidence" is in and of itself, a public health best-practice concept (6). Without accurate knowledge on the virus and its dissemination mechanisms, as well as the efficacy of potential interventions and their (direct and indirect) health and socioeconomic effects, policymakers are tasked with taking steps to protect their populations from the epidemic. However, in a volatile and rapidly evolving world, the relevant evidence is constantly changing, making it difficult to make scientifically sound assumptions about the outcomes of different courses of action (7). This propensity to fixate on a single narrative—or, more broadly, this inability to deal with uncertainty—may lead to the misinterpretation of the condition of COVID-19 outbreak, eventually leading to suboptimal decisions with potentially catastrophic consequences (8).

Moreover, there are uncertainties about the length and termination of policy decisions. Although policymakers are undergoing a wave of policy reforms aimed at addressing urgent social threats, it is unclear which of these changes will be lasting and which will be phased out. This includes concerns about how they will be phased out (in phases or at once) and the political ramifications of reversing decisions that expanded welfare benefits to deal with the immediate crisis (9).

Divergent expert evaluations or varying modeling forecasts have presented policymakers with somewhat different perspectives on possible epidemic scenarios. In the face of such confusion, politicians can try to reconcile the opposing viewpoints, or they can completely embrace one without regard for the possibility that it may greatly distort our fundamental knowledge base (10). Crisis response and management share an immediate interdependence with (1) public policies, including the substance of previously and newly enacted policy decisions, (2) the relationships of people, organizations, coalitions, and channels, and (3) crisis response and management share an immediate interdependence with contextual factors, such as income levels, local interactions, and international decisions.

POPULATIONS RESILIENCE

The COVID-19 pandemic is similar to natural disasters in that both disrupt individual and institutional practices and require society to be resilient. The COVID-19 pandemic is a global health shock, with over three million deaths and over 104 million people sickened by April 18, 2021 (11). The steps taken to monitor and mitigate it have generated a socio-economic shock, endangering people's livelihoods all over the world (12).

In disaster literature, resilience is described as a social system's ability to proactively respond to and recover from disruptions that are interpreted within the system to be beyond the range of usual and expected shocks (13). Increasing adaptability at the maneuver level is the essence of resilience. Literature on resilience looks at how it manifests itself in self-organized systems within societies (14). Simultaneously, resilience is required to work in accordance with current policymaker processes and institutions, to reinforce current practices and most importantly, to adhere to current policy frameworks (15).

Community resilience is described as a dynamic and dialogical process in which communities build, improve, and/or engage their resources in order to cope with shocks and the instability that follows (16). Many countries emerged during COVID-19 in a state of overburdened (health) services, semi-closed economies and a resulting scarcity of services and protective supplies. During this stage of the health crisis, resilience is likely to aid societies in adapting, that is, continuing to work in a "natural" manner as much as possible. In other stages of community resilience, can also assist communities in preparing for a crisis and/or restoring or even transforming after a crisis (17).

However, vulnerability is often thought to be the antithesis of resilience (18). During the COVID-19 pandemic, vulnerabilities refer to the health and socioeconomic effects of the pandemic, in which people are at risk of sickness, loss of normal life, (domestic) abuse, and/or social isolation (19). As the society faces a common challenge, increased population engagement emerges, but it is limited by the loss of community resources. Only vulnerabilities over which communities have control can be addressed, and the emphasis is likely to be on immediate and urgent conflict, prevention, or adaptation (20).

The mechanism of gaining civil acceptance of the lockdown policy in the ongoing COVID-19 emergency is partly dependent on procreating resilience like an all and somehow unavoidable logic (21). In natural disasters and health emergencies, two factors seem to be decisive. On the one hand, when individuals and communities are confronted with a shock, the social capital available within the group will dynamize the available resources of people and communities. The wider governance sense in which the initiative is formulated, on the other hand, may serve as a trigger or a constraint for resilience (22).

THE PERCEPTION BEHAVIOR OF POPULATION TOWARD POLICYMAKING

People's behavior is also affected by social expectations, such as how others are viewed, as well as moral norms and values. People were inspired to do what was right by social compliance, which allowed them to follow and internalize shared guidelines (23). It is possible to develop more effective and efficient public policy using its ideas and empirical findings, which provide information about how people actually make decisions. Behavioral insights are being implemented into public policy based on this information and complex sets of guidelines are being applied to its development and application in many countries (24).

Individual choices differ depending on situations, location, time, norms and social factors, emotional decisions, cognitive distortions and prejudices, modifying rationale applied principles, and at the same time on how and under what conditions the choice is made (the choice architecture), according to studies conducted on different aspects of human behavior (24). As a result, incorporating morality, solidarity, empathy, and compassion into local campaign messaging to promote pro-social activities, thereby improving population-mindedness and responsibility among individuals, may be successful. Moving forward, healthcare officials and policymakers would need to rely on behavioral and social science evidence to improve connectivity and populations' awareness (23).

Behavioral perspectives gathered from many of the studies suggest that people think in two ways (25). They make relative rather than absolute decisions, acts conceptually in certain cases, and is vulnerable to prejudices and biases; they fail to cope with conflicting information, so they depend on current and readily available data; they make decisions emotionally, spontaneously, and then implement them slowly or not at all; are influenced by other people's actions, relationships with them, and social norms. Understanding the perspective on human behavior, human decisions, and limited reasoning that direct the reactions of public healthcare policy receivers is therefore a critical component of successful policymaking. Human behavior research is guiding policymaking, assisting in the development of innovative ways of action and complementing conventional approaches (i.e., regulations and incentives). Furthermore, behavioral perspectives should be developed to direct potential applications and maintain citizens' trust in government policymaking (24).

TRUST AND TRANSPARENCY

The ability to leverage population cooperation and maintain the behaviors required for controlling the pandemic is dependent on indorsing trust. According to Siegrist and Zingg (26), effective pandemic communication requires high levels of trust based on shared values among participants, as well as trust that future events will unfold as anticipated. Indeed, policymakers should place a premium on accountability, particularly in circumstances where they must act quickly and with minimal consultation for the public good, as is frequently the case in public health emergencies.

However, effectively managing a pandemic necessitates large-scale behavioral adjustments on a personal, organizational, and societal level, which go beyond handwashing, facemasks, and isolation. Furthermore, crises, especially epidemics, create real barriers to efforts to balance individual and collective interests, making it difficult to implement the necessary behavioral strategy to reduce outbreak (27).

A social policy is described as "ongoing strategies for structuring relationships and coordinating behavior to achieve collective goals, ways of exerting control, of persuading people to do things they might not do" (28). The implementation of a policy necessitates the mobilization of resources from wherever they are required to carry out the policy. Sociocultural identity, age, gender and resources access all, affect people's interactions with and responses to public health information and communication.

Policymakers' unwillingness to enact targeted community health communication interventions could jeopardize their aptitudes and the health system's ability to respond to pandemics. Because of inadequate messaging by health officials and other authorities, it has been impossible for the community to differentiate between evidence-based and less objectively accurate knowledge during crisis.

In a public health crisis, transparent communication means revealing what information was used to make public-health decisions, who was consulted, and what possibilities and trade-offs were addressed. Of course, population participation can be difficult in times of crisis, when politicians must make fast, life-saving decisions that may necessitate implementing stringent measures with little to no time for community contribution. These steps can be life-changing in themselves. Also, active and continuing public involvement and collaboration with

governments, organizations, and other stakeholders, on the other hand, will help to promote restoration (29).

THE APPROPRIATE STRATEGIES TO ENGAGE THE POPULATION IN POLICYMAKING

Avoiding exposure to a highly transmissible disease or taking care of family, neighbors, and staff may be shared goals; however, the mode of delivery and the framing of vital public health information needs to be sensitive to and tailored toward specific social groups and communities (30). The argue that an effective strategy is a two-way process that involves clear messages, delivered via appropriate platforms, tailored for diverse audiences and shared by trusted people. A diversity of community groups must be included in engagement activities with the implications of emerging digital technologies (31).

The author offers a collection of suggestions for a successful pandemic plan. These suggestions are intended to serve as building blocks for broader strategies that value neighborhood diversity and demonstrate a commitment to community engagement. Many of the guidelines overlap, and there are synergistic and, in some cases, antagonistic relationships between them. The author claims that the guidelines can be used to address other public policy and national issues that cut through social, economic, and health domains. In the aftermath of the COVID-19 pandemic, there are still understudied facets of policy sciences that demand further study. These include, but are not limited to, the following research areas:

- The global response to the pandemic has increased the need for new studies not just on the flood of new policy decisions, but also on the consequences of non-decisions and policy terminations.
- The political response to the pandemic has shifted priorities, resulting in a shift in the focus and intensity of policy disagreements, but the characteristics and long-term consequences of these shifts are unclear.
- Although we know that base principles and other orientations influence policy performance and failure, there are still unanswered questions about how to manage the tradeoffs that exist between them.

CONCLUSION

It is critical that policy changes resulting from the COVID-19 crises are wise and long-lasting. Instead of short-sighted and temporary strategies, strategic planning, and foresight should be prioritized (e.g., need for sustained social safety nets). COVID-19 control allows policymakers and their constituents to form mutually supportive relationships based on a common perception of what both sets of actors predict. The ability of policymakers and public health officials to assess how the general public views the efficacy of policymaker responses to COVID-19, as well as particular roles, is critical for recognizing possible roadblocks to disease prevention. This article demonstrates that the policy sciences' strength lies in their ability to provide broad insights into the relationships between policymaking and society.

Nonetheless, given the wide variety of policies implemented by policymakers around the world, it is important to learn not only from new biomedical and epidemiological data, but also from the degree to which these values influenced practice, improved community health, and protected human rights. It is critical to participate early and build greater support and encouragement for policymaking, which is even more applicable to policy reform advocates. Despite the fact that concepts of pluralism make it more difficult to accomplish public policy due to the removal of power, pluralism does offer opportunities to raise problems for discussion and increases the likelihood of changeable reform.

AUTHOR CONTRIBUTIONS

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

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Inequalities in Knowledge About COVID-19 in the Kingdom of Saudi Arabia

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Background: As the world is still being ravaged by the coronavirus disease 2019 (COVID-19) pandemic, the first line of prevention lies in understanding the causative and preventive factors of the disease. However, given varied socioeconomic circumstances, there may be some inequality in the level of proper knowledge of COVID-19. Despite a proliferation of studies on COVID-19, the extent and prevalence of inequalities in knowledge about COVID-19 in Saudi Arabia are not known. Most related studies have only focused on understanding the determinants of COVID-19 knowledge. Therefore, the aim of this study was to assess the socioeconomic inequalities in knowledge regarding COVID-19 in Saudi Arabia.

Methods: Data were extracted from an online cross-sectional self-reported questionnaire conducted on the knowledge about COVID-19 from 3,388 participants. Frequencies and graphs were used to identify the level and distribution of inequality in knowledge about COVID-19. Concentration curves and concentration indices were further used to assess and quantify the income- and education-related inequality in knowledge about COVID-19.

Results: The level of COVID-19 knowledge was high among the surveyed sample, although the extent of knowledge varied. The findings further suggest the existence of socioeconomic inequality in obtaining proper knowledge about COVID-19, indicating that inequality in comprehensive knowledge is disproportionately concentrated among the wealthy (concentration index = 0.016; $P < 0.001$) and highly educated individuals (concentration index = 0.003; $P = 0.029$) in Saudi Arabia.

Conclusions: There is inequality in the level of knowledge about COVID-19 among the more socioeconomically privileged population of Saudi Arabia. Given that COVID-19 cases ebb and flow in different waves, it is important that proper policies be put in place that will help in improving knowledge among the lower income and less educated individuals, leading to behavior that can help reduce transmission.

Keywords: concentration curve, concentration index, COVID-19, inequality, Kingdom of Saudi Arabia (KSA)

INTRODUCTION

Coronavirus disease 2019 (COVID-19) is a respiratory disease triggered by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2; formerly called 2019-nCoV), which was initially discovered in December 2019 in Wuhan city, Hubei Province, China (1). On March 2020, COVID-19 was affirmed as a pandemic virus-related infection by the World Health Organization (WHO) with the main symptoms identified as fever, fatigue, myalgia, headache, dry cough, shortness of breath, and dyspnea, which may cause acute respiratory distress syndrome and death; moreover, COVID-19 may manifest as skin symptoms such as an erythematous rash, urticaria, and chicken pox–like lesions (2–6).

The COVID-19 pandemic has affected various spheres of life worldwide, with economic, social, and political impacts (7–9). Following the WHO declaration, countries around the globe, including the Kingdom of Saudi Arabia (KSA), have been leaning on response plans to respond to the pandemic and contain transmission of the virus. The KSA put several measures in place to control the spread of COVID-19 in the country since confirmation of its first case on 2 March 2020 (10).

The control measures taken by the government include implementation of a curfew, mass lockdown of cities and people, suspending all inbounds and outbounds flights, transportation restrictions, shutdown of schools and businesses, rapid deployment of testing protocols, and using novel technologies to trace all cases. Additionally, the religious authorities in the country declared introduction of home prayers, banning the five daily prayers in all mosques across the country, which represents an extraordinary step since Saudi Arabian law is founded on Islamic law with the majority of citizens carrying out prayers five times a day in mosques. Moreover, the Umrah was also suspended along with very limited access to the 2020 Hajj (11).

Accordingly, the KSA government established intensive awareness campaigns through the Ministry of Health (MOH) that were distributed on television, and on various social media and mobile phone platforms. Additionally, the MOH produced a guide to COVID-19 to provide residents with facts and precautionary messages that is available in more than 10 languages (10). These unprecedented efforts at all levels and public awareness campaigns led by the government have contributed to raising awareness of the pandemic among citizens, with the aim of limiting the spread of the virus. It has been argued that public adherence to measures and raising awareness of infectious diseases can greatly contribute to tackling pandemics (12, 13).

A recent study carried out to determine the knowledge, attitudes, and practice toward COVID-19 prevention among the general public in the KSA showed that the majority of people surveyed had a high level of knowledge, optimistic attitudes, and safe practices toward COVID-19 (10). Although knowledge regarding COVID-19 may appear to be relatively high in the KSA, it is important to understand if there is any socioeconomic inequality in COVID-19 knowledge and the relative contribution of various factors to this inequality beyond simply identifying the determinants.

Given varied socioeconomic circumstances, there may be some inequality in the level of proper knowledge of COVID-19. Despite a proliferation of studies on COVID-19, the extent and prevalence of inequalities in knowledge about COVID-19 are still not known. Most of the related studies have primarily focused on understanding the determinants of COVID-19 knowledge, attitudes, and perceptions in Saudi Arabia (10, 14, 15), Jordan (16), Egypt (17), Bangladesh (18), and China (19). All of these previous studies found age and education to be among the principal determinants of having proper COVID-19 knowledge, practices, and attitudes. Another study focusing on the potential link between COVID-19 and mental health found that the pandemic appears to be associated with increased stress among healthcare workers in the KSA (20).

As there is a dearth of empirical literature focusing on socioeconomic inequality in COVID-19 knowledge, the aim of this study was to assess the socioeconomic inequality in knowledge regarding COVID-19 in the KSA, based on the use of concentration indices and concentration curves, and identifying the extent to which various factors contribute to any observed inequality in this knowledge. Several factors served as the motivation to perform this study, including established variation in the knowledge levels regarding COVID-19, but without an understanding if socioeconomic inequality contributes to this variation. Proper knowledge regarding an epidemic/pandemic is important in the management of any disease. To our knowledge, this is the first study to assess socioeconomic inequality in knowledge regarding COVID-19 in a quantitative manner using concentration indices and concentration curves.

MATERIALS AND METHODS

Study Design and Sample

The data for this study were extracted from an online cross-sectional self-reported questionnaire that was conducted to investigate the knowledge of the Saudi public toward COVID-19 from 20 March 2020 to 24 March 2020 (10). The online questionnaire was developed according to guidelines for the community of COVID-19, by the Centres for Disease Control and Prevention (CDC) (21). The questionnaire was originally designed in English and translated into Arabic. The questionnaire was translated then back to English to ensure the meaning of the content. The Arabic text was used to administer the study. The survey was administered online to comply with government restrictions put in place to limit human contact so as to minimize COVID-19 transmission. Participants were provided with a questionnaire administered using modern survey techniques, including use of the SurveyMonkey Inc. (San Mateo, CA, USA) distributed to the respondents via Twitter (San Francisco, CA, USA) and WhatsApp Inc. (Mountain View, CA, USA). Participants were recruited using a simplified snowball sampling technique, where the invited participants were requested to pass on the invitations to their contacts. This online survey approach was feasible owing to the high rate of digital adoption in the KSA (4).

According to the latest KSA census, Saudi Arabia has a population of 34,218,169 (22). The representative target sample size needed, to achieve the study objectives and sufficient statistical power, was calculated with a sample size calculator (23). Using a margin of error of +/– 4%, a confidence level of 99%, a 50% response distribution, and 34,218,169 people, the sample size calculator arrived at 1,037 participants. The targeted respondents included being aged 18 years or older and living in the KSA at the time of data collection. Online informed consent was obtained from all participants before proceeding with the questionnaire. A total of 3427 participants completed the questionnaire. After excluding 39 respondents who reported living outside the KSA, the final sample consisted of 3,388 participants.

Outcome Variable

The dependent variable for this study is the score of the knowledge related to COVID-19. Knowledge of COVID-19 was quantitatively assessed based on the responses to knowledge items in the survey as either true or false, with an additional "don't know" option. Whenever the respondent provided a correct answer, a score of 1 was given, whereas if an incorrect or uncertain (don't know) response was given, a score of 0 was assigned for that question. In total, an aggregate score for knowledge was calculated, which ranged from 0 to 22. A higher score indicates better knowledge of COVID-19, whereas a lower score indicates low knowledge. To assess the internal reliability, Cronbach's alpha was calculated; a Cronbach's alpha value of at least 0.70 demonstrates internal reliability of the instrument (24). Details on the measurement tool can be found elsewhere (10).

Explanatory Variables

Some explanatory variables were also assessed to place the results in context. Respondents were asked about their socio-demographic characteristics, including their gender, age, marital status, education level, employment status, income level, and region in which they were currently residing. Gender was coded as a binary variable, with a value of 1 assigned for men and 0 for women. The age variable was divided into five categories: 18–29 (reference category), 30–39, 40–49, 50–59, and ≥60 years. This categorization was used to investigate whether there was any difference in the knowledge related to COVID-19 according to age group. With respect to marital status, individuals were assigned a value of 1 if they reported being married and were assigned a value of 0 for unmarried (including single, widowed, and divorced). Education level was categorized as high school or below (reference category), college/university degree, and postgraduate degree. Employment status was classified as government employee (reference category), non-government employee, retired, self-employed, and unemployed. Monthly income (Saudi Riyal, SR 1 = USD 0.27) was grouped into eight categories: < SR 3,000 (reference category), SR 3,000 to <5,000, SR 5,000 to <7,000, SR 7,000 to <10,000, SR 10,000 to <15,000, SR 15,000 to <20,000, SR 20,000 to < 30,000, and SR 30,000 or more. We also controlled for variation among the 13 administrative regions of the KSA: Almadina Almonawra, Albaha, Aljouf/Quriat, Aseer/Bisha, Eastern Region, Haiel, Jazan, Najran, Northern Borders, Qaseem, Riyadh, Tabouk, and Western Region.

Data Analyses

Various levels of analysis were performed. Firstly, frequencies of individual variables of interest were calculated to understand their distribution. Secondly, to assess socioeconomic inequality, the methodology of Wagstaff et al. (25) was adopted. This includes visualization and estimation of inequalities using the concentration curve and the concentration index.

The concentration curve is a visual approach that plots the cumulative percentage of a health variable on the vertical axis against the cumulative share of that variable in the population (ranked from the lowest to the highest by an indicator of the socio-economic status [SES]) on the horizontal axis. A concentration curve above (below) the line of equality indicates that the proper knowledge related to COVID-19 is concentrated among the poor (rich). The further the concentration curve is away from the line of equality (i.e., the 45-degree line), the greater the degree of inequality.

The concentration index was calculated as twice the area between the concentration curve and the line of equality to quantifies the degree of socioeconomic-related inequality in health or healthcare use (26). The concentration index is defined mathematically as;

$$\mathrm{CI} = \frac{2}{\mu} cov(y_i, r_i) \tag{1}$$

where *yi* is the indicator of COVID-19 knowledge for an individual *i*, *ri* is the fractional ranking of individuals according to SES and μ is the mean of *yi*. The concentration index can be either negative or positive and ranges between +1 and −1. In this analysis, a negative concentration index indicates that proper knowledge is concentrated among individuals with a relatively low SES, whereas a positive concentration index means that proper COVID-19 knowledge is concentrated among the relatively higher SES. A concentration index of 0 means that no inequality exists in the knowledge of COVID-19.

Moving beyond concentration index calculation, we take a step to understand how each factor contribute to the observed socioeconomic inequality in the knowledge about COVID-19. This is an important analysis for policymakers to pinpoint the variables they will prioritize to reduce the observed socioeconomic inequality. The decomposition method used employed Wagstaff approach (27). This method enables to partition inequality into its contributing factors. To show this, assume that Y_i knowledge of COVID-19 is a linear and additively separable function X_j, the vector of covariates is obtained as:

$$Y_i = \alpha + \beta_j X_{ji} + \varepsilon_i \tag{2}$$

The concentration index can then be expressed as a weighted sum of the aggregated indices of the different explanatory variables in the model for COVID-19 knowledge with respect to the measure

of SES (27), as follows:

$$CI = \sum_{j=1}^{J} \beta_j \frac{\overline{X}_j}{\mu} CI_j + \frac{GCI_\varepsilon}{\mu} \quad (3)$$

Where β_j represents the partial effect of knowledge determinants, CI_j represents the concentration indices of $\overline{X}_j$, and GCI_ε is the generalized concentration index of the error term. Equation 3 illustrates that the contribution of each variable to inequality is based on the interaction between the elasticity of COVID-19 knowledge ($\beta_j^* \frac{\overline{X}_j}{\mu}$) with respect to that variable and SES-related inequality in the distribution of the variable. All analyses were conducted using STATA software (StataCorp LP, Texas, USA).

Ethical Approval

All procedures performed in this study involving human participants complied with institutional and/or national research committee ethical standards, and with the 1964 Helsinki Declaration and subsequent amendments or equivalent ethical standards. This research has been reviewed and given a favorable opinion by King Abdulaziz University. The study was designed and conducted in accordance with the ethical principles established by King Abdulaziz University. Therefore, ethical approval was obtained from the Biomedical Ethics Research Committee, Faculty of Medicine, King Abdulaziz University (Ref-180-20).

RESULTS

Social and Demographic Characteristics

Table 1 presents the social and demographic characteristics of the 3,388 participants included in the analysis for this study. The mean COVID-19 knowledge score was 17.96 ($SD = 2.24$, range: 3–22). In terms of gender, 1,966 (58.03%) were women, and 1,422 (41.97%) were men. The predominant age of the respondents was 18–39 years (an aggregate of 57.73%). The number of married participants was 2,149 (63.43%), whereas 1,239 were unmarried (36.57%). With respect to education level, 56.20% of the respondents had a college or university degree. Less than half of the respondents reported being unemployed (31.76%). According to monthly income, 846 (24.97%) respondents were in the lowest group (SR < 3,000), and 246 (7.26%) were in the highest group (SR ≥ 30,000).

Econometric/Statistical Analyses

To assess socio-economic inequalities in the knowledge about COVID-19, concentration indices and concentration curves were used. **Figures 1**, **2**, depict the concentration curves by income and education, respectively. **Figure 1** shows that the concentration curve lies to the right-hand side of (below) the line of inequality, indicating the existence of inequality in knowledge regarding COVID-19. **Figure 2** shows that the concentration curve was bordered to the right of (below) the line of equality. These analyses thus support that knowledge regarding COVID-19 is disproportionately concentrated among the wealthy and highly educated people in the KSA.

TABLE 1 | Social and demographic characteristics of study participants.

Variable	Mean	SD	Min	Max	N	%
Knowledge score	17.96	2.24	3	22		
Gender						
Female					1,966	58.03
Male					1,422	41.97
Age (years)						
18–29					1,016	29.99
30–39					940	27.74
40–49					692	20.43
50–59					472	13.93
≥60					268	7.91
Marital status						
Not married					1,239	36.57
Married					2,149	63.43
Education						
High school or below					539	15.91
College/university degree					1,904	56.20
Postgraduate degree					945	27.89
Work status						
Government employee					1,320	38.96
Non-government employee					546	16.12
Retired					314	9.27
Self-employed					135	3.98
Unemployed					1,073	31.67
Monthly income (SR)						
<3000					846	24.97
3000 to <5000					293	8.65
5000 to <7000					258	7.62
7000 to <10,000					356	10.51
10,000 to <15,000					584	17.24
15,000 to <20,000					472	13.93
20,000 to <30,000					333	9.83
≥30,000					246	7.26
Region						
Albaha					15	0.44
Aljouf/Quriat					10	0.30
Almadina Almonawra					147	4.34
Aseer/Bisha					149	4.40
Eastern Region					166	4.90
Haiel					17	0.50
Jazan					19	0.56
Najran					16	0.47
Northern Borders					4	0.12
Qaseem					38	1.12
Riyadh					535	15.79
Tabouk					15	0.44
Western Region					2257	66.62

The study further assessed the variation in COVID-19 knowledge by education status in further detail. **Figure 3** shows that knowledge was higher among highly educated (those with a university degree and above) and was lower among the

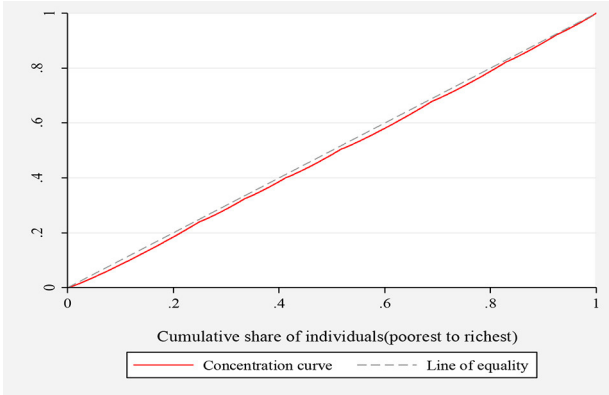

FIGURE 1 | Concentration curve for inequality in COVID-19 knowledge ranked by income.

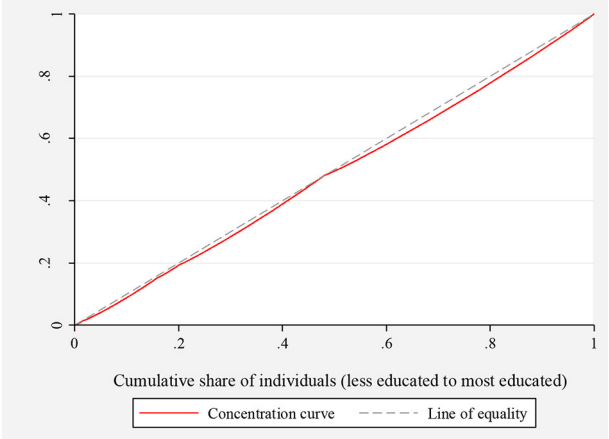

FIGURE 2 | Concentration curve for inequality in COVID-19 knowledge ranked by education.

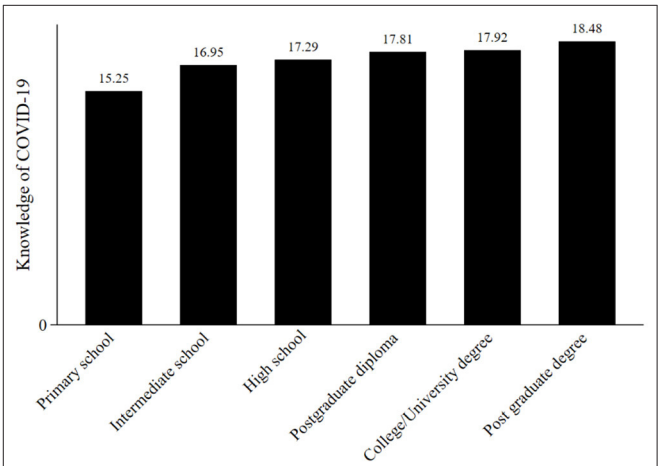

FIGURE 3 | Knowledge of COVID-19 ranked by education level.

less educated (those with only a primary school education), indicating a positive trend.

Since the concentration curves do not indicate the magnitude of inequality, we quantified the overall income- and education-related inequality using the concentration indices. The concentration index value for income was significant and positive (0.016, standard deviation = 0.001, $P < 0.001$), indicating that inequality in the knowledge of COVID-19 was concentrated among high-income individuals. Consistently, the concentration index for education was positive and significant (0.003, standard deviation = 0.001, $P = 0.029$), indicating more knowledge of COVID-19 among the most highly educated population in the KSA. These results support the findings from concentration curves presented in **Figures 1**, **2**.

We further assessed the inequality in COVID-19 knowledge among individuals across regions. Although most of the Erreygers index values in each region were positive, there was substantial heterogeneity across regions with respect to ranking according to both education and income. As shown in **Table 2**, all of the Erreygers indices, except in Northern Borders, were positive; the highest value was obtained in Haiel (0.023; $P < 0.05$), followed by the Qaseem (0.022; $P < 0.10$). Regarding education, the highest value was obtained in Asser/Bisha (0.015; $P < 0.01$), followed by Western region (0.013; $P < 0.01$).

Finally, we analyzed how specific factors contribute to the observed inequality in knowledge related to COVID-19. **Table 3** shows the results. The analysis showed that much of the inequality is explained by the highest income group SR 20,000 to <30,000 (contribution = 0.003), and SR ≥30,000 (contribution = 0.003). The aggregate contribution of income being about 0.009 (summation of the income contributions). For age, the contributions stand at an aggregate of 0.007. See **Table 3** for full details.

DISCUSSION

To the best of our knowledge, this study provides the first empirical evidence on the existence of socioeconomic inequality in knowledge related to COVID-19 in the KSA. With the spread of COVID-19, numerous countries, including Saudi Arabia, declared a state of emergency, instituting stay-at-home orders, closing schools, and suspending flights. Although these unprecedented policies may help to curb the spread of the virus, having better knowledge impacts how people relate to the disease and behave. Indeed, knowledge has been shown to contribute to an individual's health-related decision-making (28). For instance, in Saudi Arabia, vulnerable groups such as those with a low SES reported lower adoption of preventive measures (29), which may be partly attributed to lower levels of knowledge about the disease. Previous research on infectious diseases has shown that knowledge and beliefs are significant predictors of the adoption of preventive behaviors (30–32). Therefore, the aim of this study was to assess socioeconomic inequalities in COVID-19–related knowledge among the Saudi population during the early stages of the pandemic. Understanding the extent of COVID-19 knowledge among different SES groups can help to enhance

TABLE 2 | Concentration indices for the knowledge about COVID-19 by income and education across regions.

	Income ranking		Education ranking	
Region	**Erreygers index**	**Confidence interval**	**Erreygers index**	**Confidence Interval**
AlBaha	0.009	[−0.018, 0.036]	−0.001	[−0.031, 0.029]
AlJouf/Quriat	0.029	[−0.009, 0.067]	0.016	[−0.029, 0.062]
AlMadina Almonawra	0.008	[−0.004, 0.020]	0.013**	[0.001, 0.024]
Aseer/Bisha	0.015***	[0.005, 0.025]	0.015***	[0.006, 0.024]
Eastern Region	0.007	[−0.003, 0.017]	0.005	[−0.007, 0.016]
Haiel	0.023**	[0.000, 0.047]	0.014	[0.005, 0.022]
Jazan	0.006	[−0.023, 0.036]	0.010	[−0.020, 0.041]
Najran	0.008	[−0.012, 0.028]	0.011	[−0.008, 0.030]
Northern Borders	−0.020	[−0.078, 0.038]	0.001	[−0.020, 0.022]
Qaseem	0.022*	[−0.003, 0.048]	0.016	[−0.013, 0.045]
Riyadh	0.014***	[0.007, 0.020]	0.009***	[0.001, 0.021]
Tabouk	0.004	[−0.026, 0.034]	0.014	[−0.008, 0.036]
Western region	0.017***	[0.014, 0.020]	0.013***	[0.010, 0.016]

$^{***}P < 0.01$, $^{**}P < 0.05$, $^{*}P < 0.1$.

the public health emergency response to infectious diseases. This is necessary given that a society's response to an emergency crisis largely depends on meeting the needs of all population subgroups, especially those who are vulnerable and subject to diversity (28).

In this study, knowledge was evaluated by elucidating participants' knowledge of the epidemiological characteristics of the disease and knowledge of actions that can be taken to minimize exposure to COVID-19. The results reveal that the mean COVID-19 knowledge score was 17.96 ($SD = 2.24$, range: 3–22). This indicates that most study participants demonstrated good knowledge about COVID-19. This finding is consistent with findings from other studies conducted in the KSA (14, 33). Nevertheless, inequality in knowledge was observed in this study.

The results of our study showed that income is related to inequalities in knowledge about COVID-19. Knowledge regarding COVID-19 was significantly concentrated among people with higher SES. The significant positive Erreygers concentration index suggests that the richer have a better advantage in terms of knowledge than the poorer. Although these results cannot be directly compared to other studies since this is the first study to use concentration indices to determine inequalities in this regard, the findings closely mimic some related research from Saudi Arabia (10, 14, 15), showing a positive relationship between COVID-19 knowledge and income. Moreover, our findings of high-income earners having more knowledge regarding COVID-19 than low-income earners is in line with other studies conducted in the USA (34), Northern Thailand (35), and Ethiopia (36). Inequality in COVID-19–related knowledge between low- and high-income groups might be due to greater amounts of exposure to misinformation for the former group with greater access to reliable sources of information for the latter group (37).

This study also showed that another SES factor, level of educational attainment, is strongly associated with inequalities in knowledge about COVID-19, which was consistent with an earlier study (38). The results of this study showed that proper knowledge about COVID-19 is concentrated among highly educated individuals. In previous studies, level of education was identified as an important predictor of knowledge for other communicable diseases such as influenza H1N1 (28). Taken together, these findings suggest that an increased level of educational attainment can enhance an individual's readiness to receive and process complex information, even under uncertain conditions that might complicate the message (28). The association between level of education and knowledge about COVID-19 found in this study indicates that in the early stages of the pandemic, communication strategies about the virus did not reach those with lower educational attainment. Although this may have changed later on, these data suggest that public health authorities should consider differences among population subgroups when developing and designing public communication strategies. Tools and strategies testing their effectiveness and evaluating their impact on the population should also be developed.

Moreover, regional inequalities were also found. The income-based concentration indices and education-based concentration indices were positive and significant for some regions. This indicates inequality related COVID-19 across regions. For example, the income-based concentration indices were positive and significant for Aseer, Haiel, Riyadh and the Western Region. This indicates that residents of Haiel, Riyadh and the Western Region had more knowledge than those of other regions in the country. Although the reason behind this regional variability is unclear, differences in knowledge between different regions in the country can be attributed to the average income between regions. Moreover, this may be due to variation in the circumstances surrounding the opportunities brought about by the respective provincial economies.

TABLE 3 | Decomposition of concentration index in COVID-19 knowledge according to demographic variables.

Variables	Coefficient	Concentration index	Elasticity	Contribution	%
Gender					
Female (ref)					
Male	−0.316***	0.069***	−0.025***	−0.002***	−10.958
	(0.093)	(0.003)	(0.007)	(0.001)	(3.583)
Age					
18–29 (ref)					
30–39	0.732***	0.063***	0.011***	0.001***	4.488
	(0.131)	(0.017)	(0.002)	(0.000)	(1.663)
40–49	0.620***	0.225***	0.007***	0.002***	10.060
	(0.125)	(0.016)	(0.001)	(0.000)	(2.643)
50–59	0.920***	0.333***	0.007***	0.002***	15.056
	(0.190)	(0.019)	(0.001)	(0.001)	(3.743)
≥60	0.783***	0.464***	0.003***	0.002***	10.148
	(0.200)	(0.024)	(0.001)	(0.000)	(2.882)
Marital status					
Unmarried (ref)					
Married	0.166**	0.184***	0.006**	0.001**	6.851
	(0.078)	(0.007)	(0.003)	(0.001)	(3.374)
Education level					
High school or below (ref)					
College/university degree	0.574***	−0.090***	0.018***	−0.002***	−10.259
	(0.137)	(0.009)	(0.004)	(0.000)	(2.908)
Postgraduate degree	0.748***	0.378***	0.012***	0.004***	27.883
	(0.136)	(0.012)	(0.002)	(0.001)	(5.919)
Work status					
Government employee (ref)					
Non-government employee	0.148	0.028	0.001	0.000	0.236
	(0.131)	(0.020)	(0.001)	(0.000)	(0.300)
Retired	0.180	0.375***	0.001	0.000	2.214
	(0.170)	(0.019)	(0.001)	(0.000)	(2.065)
Self-employed	0.116	0.212***	0.000	0.000	0.346
	(0.195)	(0.058)	(0.000)	(0.000)	(0.593)
Unemployed	0.183	−0.563***	0.003	−0.002	−11.504
	(0.146)	(0.012)	(0.003)	(0.001)	(9.476)
Monthly income (Saudi Riyal)					
<3000 (ref)					
3000 to <5000	0.088	−0.414***	0.000	−0.000	−1.108
	(0.176)	(0.015)	(0.001)	(0.000)	(2.289)
5000 to <7000	0.037	−0.251***	0.000	−0.000	−0.254
	(0.196)	(0.017)	(0.001)	(0.000)	(1.389)
7000 to <10,000	0.210	−0.070***	0.001	−0.000	−0.547
	(0.184)	(0.019)	(0.001)	(0.000)	(0.577)
10,000 to <15,000	0.394**	0.207***	0.004**	0.001**	4.977
	(0.178)	(0.019)	(0.002)	(0.000)	(2.152)
15,000 to <20,000	0.532***	0.519***	0.004***	0.002***	13.593
	(0.198)	(0.016)	(0.002)	(0.001)	(4.944)
20,000 to <30,000	0.765***	0.756***	0.004***	0.003***	20.104
	(0.187)	(0.011)	(0.001)	(0.001)	(4.880)
≥30,000	0.779***	0.927***	0.003***	0.003***	18.548
	(0.267)	(0.005)	(0.001)	(0.001)	(6.295)

(Continued)

TABLE 3 | Continued

Variables	Coefficient	Concentration index	Elasticity	Contribution	%
Region					
Riyadh (ref)					
Albaha	−0.583	0.173	−0.000	−0.000	−0.105
	(0.627)	(0.165)	(0.000)	(0.000)	(0.186)
Aljoof	0.018	0.013	0.000	0.000	0.003
	(0.416)	(0.043)	(0.001)	(0.000)	(0.270)
Aseer	−0.194	0.065*	−0.000	−0.000	−0.197
	(0.425)	(0.036)	(0.001)	(0.000)	(0.407)
Eastern Region	−0.280	0.096***	−0.001	−0.000	−0.463
	(0.450)	(0.034)	(0.001)	(0.000)	(0.782)
Haiel	−0.420	0.165	−0.000	−0.000	−0.123
	(0.487)	(0.115)	(0.000)	(0.000)	(0.173)
Jazan	−0.018	−0.155*	−0.000	0.000	0.005
	(0.505)	(0.088)	(0.000)	(0.000)	(0.179)
Madenah	−0.410	0.095	−0.000	−0.000	−0.065
	(0.506)	(0.098)	(0.000)	(0.000)	(0.149)
Mekkah	−0.086	0.285***	−0.000	−0.000	−0.010
	(0.915)	(0.062)	(0.000)	(0.000)	(0.114)
Najran	−0.247	−0.074	−0.000	0.000	0.072
	(0.423)	(0.079)	(0.000)	(0.000)	(0.184)
Northern Border	−0.306	0.170***	−0.003	−0.000	−2.911
	(0.386)	(0.021)	(0.003)	(0.001)	(3.657)
Qassim	0.293	−0.297**	0.000	−0.000	−0.136
	(0.562)	(0.133)	(0.000)	(0.000)	(0.320)
Tabuk	−0.337	−0.051***	−0.013	0.001	4.059
	(0.380)	(0.006)	(0.014)	(0.001)	(4.399)
N	3,388	3,388	3,388	3,388	3,388
Explained inequality				0.0150	100
Overall inequality				0.0157	
Residual				0.0007	

*$p < 0.10$, **$p < 0.05$, ***$p < 0.01$.
Bootstrapped standard errors in blackest.

After decomposition, of the Erreygers index, we found that a large share of the inequality is explained by the income inequality. Not only that, age, also played a significant role, in addition to the education related inequalities. All these put together may be assumed to affect inequality and incomes probably being the transmission route through which they are playing. Since these factors always reinforce each other, they may indeed push the inequality through some sort of a vicious circle. However, despite these being the major factors, it doesn't rule out the impact of the other factors, although they are somehow smaller in terms of the contribution.

In terms of policy, we may suggest that the authorities should devise strategies that, take into account, differences in income and education to ensure widespread outreach. For example, they should enhance the dissemination of more messages on social media, since most people may have access to that. Moreover, they may consider the use of community outreach by health personnel, where they would educate people in their local environment, which would cover issues to do with low income and less education. This would be the case since the health personnel would be tasked, in accordance with the community, they would be paying a visit at a specific point in time.

In spite of the above findings and recommendations, this study is not without limitations. The construction of our dependent variable is based on a well-known study (10) but is also different from the variables used in other studies (39, 40). Therefore, the difference in the type of measure used may have an impact on assessing the inequality for the variable. Moreover, the nature of our analysis does not permit making inferences related to causality. Endogeneity may be present because the variable of interest is constructed from recall, which may suffer from reporting bias. We could not find an appropriate instrument variable from the data that could appropriately deal with the potential endogeneity issue. Because of the highlighted shortfalls, the implication for future research is that using quasi-experimental identification methods such as instrumental variable matching or synthetic cohort analysis (41, 42) may be better to control for reverse causality. Furthermore, it may also

be important to use different measures of the knowledge score that would enable comparisons of the outcome. Lastly, our study did not use a complex sample survey that appropriately stratifies the KSA population. In the absence of a complex sample survey this result may only apply to the sample collected.

CONCLUSIONS

In conclusion, inequality in knowledge related to COVID-19 in the KSA highlights the importance of ensuring the dissemination of health information to all subgroups of the population, regardless of their social class or individual and geographic backgrounds. Our findings suggest that public health authorities may need to tailor more creative communication strategies and select different communication channels that can be used to diffuse health information to all social groups. As a way forward, in terms of directions for further research, it may be important to use a Sharpley decomposition to understand the drivers of this inequality. Our current data do not allow for such a complicated analysis.

DATA AVAILABILITY STATEMENT

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 (MA-H) on reasonable request.

ETHICS STATEMENT

This research has been reviewed and given a favorable opinion by King Abdulaziz University. The study was designed and conducted in accordance with the ethical principles established by King Abdulaziz University. Therefore, ethical approval was obtained from the Biomedical Ethics Research Committee, Faculty of Medicine, King Abdulaziz University (Ref-180-20).

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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Experience and Discussion: Safeguards for People With Disabilities During the COVID-19 Pandemic in China

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The special vulnerability of people with disability (PWD) in the COIVD-19 pandemic has been confirmed by many studies, but data shows that the infection rate of PWD in China is lower than for non-disabled people. We believe that this difference can be attributed to the Chinese government's targeted safeguards for the disabled community during the pandemic, including support for disability empowerment, the establishment of a remote interactive decision-making system, fair vaccine distribution and economic protection for PWD. The professionalism of decision-makers and the maintenance of channels of interaction with PWD are also important. All of these changes have benefitted China's public health policy and legal framework. This system, which has six components (governance, prevention, response, knowledge, coordination, and people), enables the country to quickly formulate a series of safeguards for PWD that have a sufficient legal basis. We believe that China's rapidly improving public health policy and legal framework will make a hugely significant impact by alleviating the impact of the COVID-19 pandemic on the PWD community. Countries should pay more attention to discovering the special needs and obstacles of PWD in the COIVD-19 pandemic: in referring to China's experience, they should explore the protection framework for persons with disabilities and adjust it to their own needs on the basis of national conditions.

Keywords: COVID-19 pandemic, disability empowerment, healthcare discrimination, people with disability, interactive decision-making system, vaccine distribution

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INTRODUCTION

As of July 9, 2021, the COVID-19 pandemic has caused 185,291,530 infections in more than 200 countries and regions, and 4,010,834 deaths (1). It has become the most severe post-WW2 public health crisis (2).

PWD account for about 15% of the world's total population (3) and are a key population in global public health (4); when compared with non-disabled people, disability makes this group more physically vulnerable and more susceptible to infection, and this is confirmed by a PWD report that shows they are four times more likely to experience poor health (5); in addition, it is also much more difficult for them to be included in health promotion programs (6). In medical care services (especially preventive medical services), there are also general differences between them and the able-bodied (7). These disadvantages mean they face a greater risk of death, even in non-pandemic environments. For example, evidence from the US suggests that adults with any disability are more likely to die than those without disabilities (8).

The COVID-19 pandemic has magnified the special vulnerability of PWD. But PWD face various inequality-related challenges in the previous worldwide COVID-19 emergency response. First of all, a considerable amount of public health information is not accessible, and this may place PWD at a clear disadvantage when they seek to obtain public health information (9). Second, the social distancing measures adopted by some countries in response to COVID-19 may make it difficult for PWD to obtain necessary care services, and this may obstruct their recovery and even endanger their lives (10). Finally, PWD experience considerable disadvantage in the allocation of medical resources in many countries, and the COVID-19 pandemic may further exacerbate this problem (11). The survey results of the global COVID-19 disability rights monitor show that COVID-19 has had a catastrophic impact on PWD worldwide (12). For example, in New York State, data made available on May 28, 2020 shows that people with intellectual disabilities are more than four times more likely to be infected with COVID-19 than non-disabled counterparts (13). In the UK, PWD were 2-3 times more likely to die from COVID-19 in the period January–November 2020 (14).

In addition, the pandemic has had a comprehensive impact on PWD. Their significantly disadvantaged position, which is confirmed by their relative economic status and education levels, has further increased their specific vulnerability in the pandemic (15). This means they are more prone to unemployment, poverty or food insecurity during the pandemic. Both education and work have increasingly shifted online during the pandemic, and this has further widened the digital divide between PWD and non-disabled people (16, 17). Many remote software platforms are not accessible to PWD, and this has further hindered their access and use (18, 19).

The pandemic has now lasted for more than a year. The difficult situation of PWD in the pandemic has increasingly preoccupied decision-makers in various countries. For example, the state of Alabama in the United States quickly canceled ventilator rationing guidelines that were criticized as an example of disability discrimination (20). The Spanish government began to issue disability benefits to PWD affected by COVID-19 (21), and its UK counterpart has prioritized PWD in its vaccine distribution. We calculate that the vaccination rate of PWD in England is 91.2%, which is 1.6% higher than the rate for non-disabled people (22). These actions will help to alleviate the impact of the pandemic on disabled groups.

China's effective epidemic prevention measures also deserve attention. As shown in **Figure 1**, data from the World Health Organization (WHO) shows that China had successfully controlled the spread of the virus in its territory before the first vaccinations were given on March 15, 2021. Data for daily new cases that covers the past through months, also suggests that the spread of the Delta strain, following on from an outbreak in Nanjing, China in July 2021, has been rapidly brought under control.

Abbreviations: PWD, people with disability; PHE, public health emergencies; IDM, interactive decision making.

Information provided by the China Disabled Persons' Federation, the largest disabled persons' rights organization in China, suggests that the infection rate of Chinese PWD may be significantly lower than for non-disabled counterparts (23). After this was announced, many of the country's regions disclosed their own infection data about PWD to the media. This suggests the infection rate of PWD in many regions of China is generally very low, and in some regions (such as Hainan Province which has a population of more than 10 million) has even reached 0 (24).

This article now provides a discussion of China's public health policy and legal framework, and seeks to identify how the government and other policy actors have sought to protect the health of PWD during the COVID-19 pandemic.

CHINA'S PUBLIC HEALTH POLICY AND LEGISLATIVE FRAMEWORK

China is a typical code law country (25). As shown in **Figure 2**, the constitution is at the top of its legal pyramid and has the highest legal effect. All other laws are formulated and amended in accordance with the Constitution. Below it, there are a series of basic laws, ordinary laws, administrative regulations, departmental rules and local regulations that are positioned in descending order Lower-level law cannot violate the provisions of the upper-level law, and nor can it stipulate the contents of upper-level law (26).

The Constitution stipulates China's public health undertakings in seven articles. Of these, Articles 21 and 45 define the basic principles of China's health policy and legislation, as shown in **Figure 3**.

These Articles emphasize that the Government has an obligation to protect people's health, and also requires that the country's health policies and legislation must adhere to the following basic principles: First, to inherit Chinese traditional medicine. The Constitution stipulates that Chinese traditional and modern (Western) medicine have the same important developmental value. Second, the state should apply a series of measures to develop medical and health commitments, including protecting people's health and enhancing their physique. This includes encouraging and supporting actors other than the Government to establish more medical and health facilities, and promoting mass sanitation activities. Third, Chinese citizens have a right to receive help from the state and society when they are old, ill or disabled, and it is established that the State should actively and effectively respond to requests made by such groups, and PWD and disabled soldiers in particular, in a variety of ways.

In applying these principles, the Government has established a huge public health policy and legislative framework. On the basis of referring to the Commonwealth public healthy policy framework (27), we believe that China's public health law and policy framework can be summarized as a system composed of six components, specifically "governance, prevention, response, knowledge, coordination, and people."

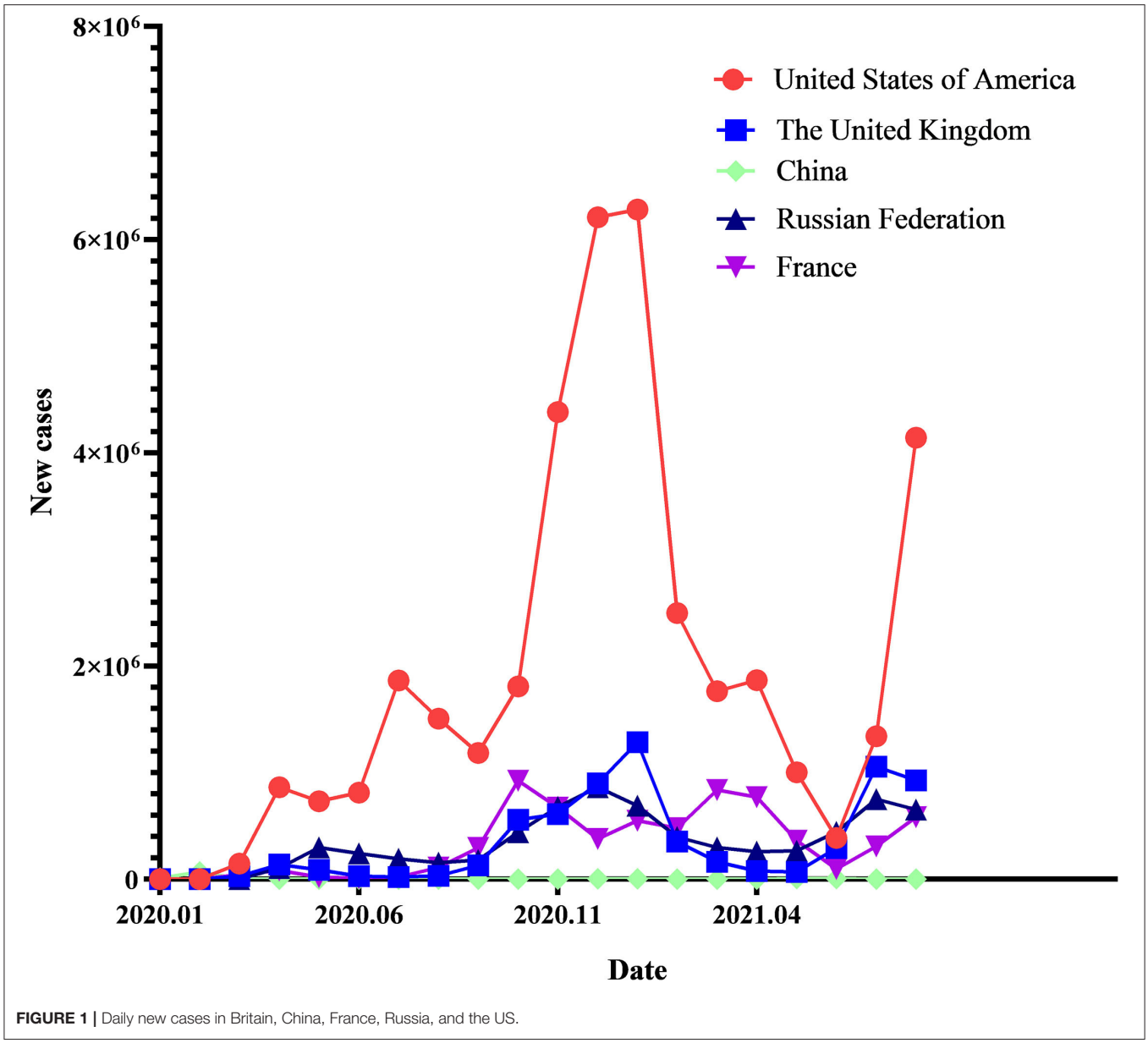

FIGURE 1 | Daily new cases in Britain, China, France, Russia, and the US.

Governance

An institutional framework for regulating the functions, roles and responsibilities of medical and public health institutions. It includes the management system of doctors and nurses and the management and planning of medical care.

Prevention

The institutional framework for preventing public health risks. It includes the vaccine management, health norms and protection standards and public health risk reporting systems.

Response

The emergency system framework used to respond to public health emergencies or infectious disease pandemics. It includes the travel restriction, lockdown and material guarantee systems.

Knowledge

The institutional framework of public health knowledge. It includes medical and pharmaceutical research norms; drug and medical device research; development and production norms; standard treatment plan research; and promotion systems.

Coordination

The cooperation and communication system that works with the public health institutions of other countries and/or international health organizations.

People

The framework of a targeted security system that benefits specific groups. It includes the security system of medical care for

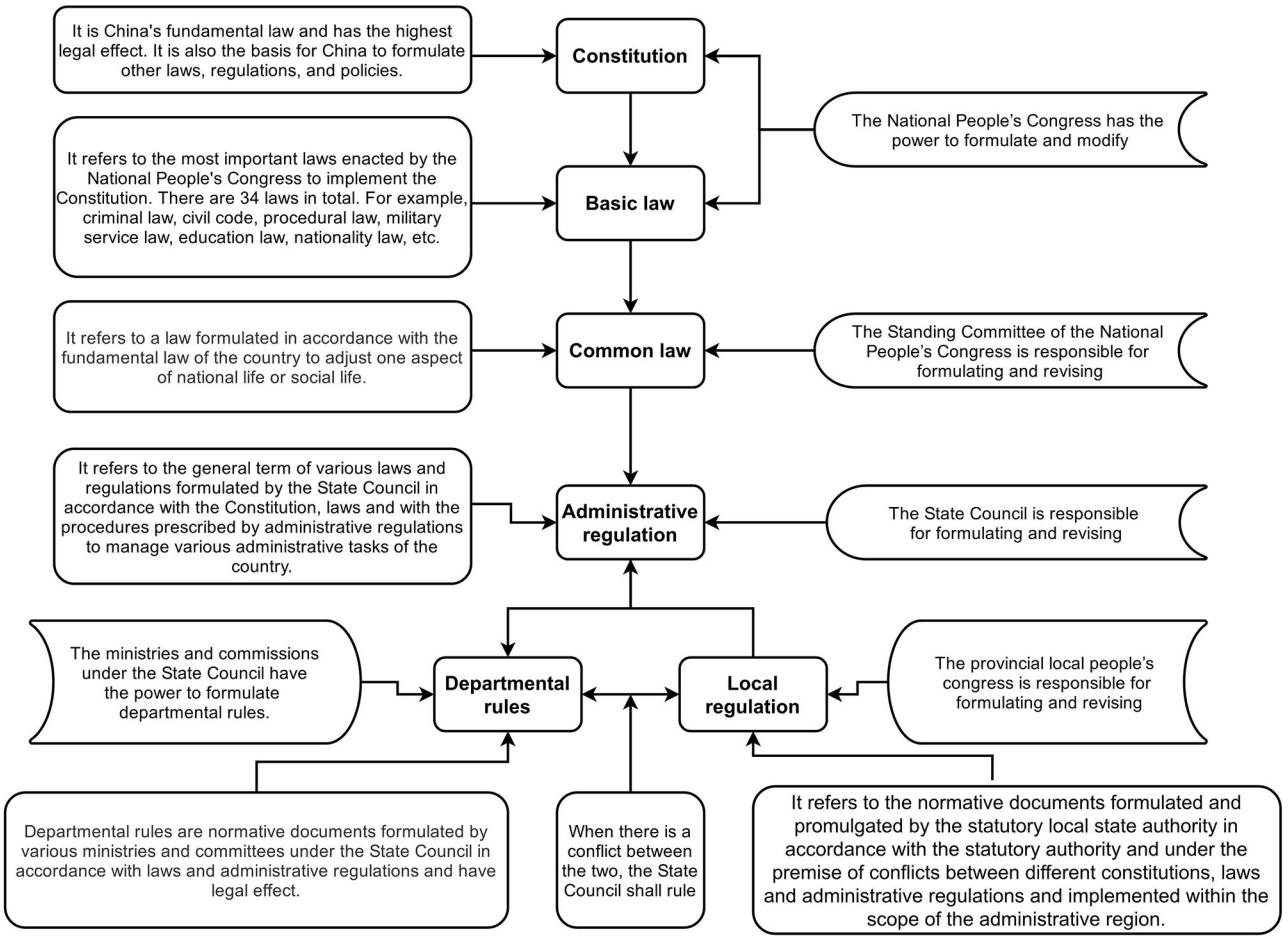

FIGURE 2 | China's legal system.

disabled people and the relief system for the needy during public health emergencies or infectious disease pandemics.

In **Figure 4**, we summarize important laws and policies that are part of the six components, with the aim of making it possible to visualize this framework.

China prepared a complete public health legislative framework before the COVID-19 pandemic that was based on its previous experience of fighting SARS (28). In the PHE period, key elements such as community participation, human resources, material rationing, social blockade and social relief were all prepared at the legislative level. During the pandemic, the Government was able to quickly formulate various safeguard measures for PWD without having to commit substantial amounts of time to revising the law.

SAFEGUARD MEASURES FOR CHINESE PWD DURING THE COVID-19 PANDEMIC

In working within the existing institutional framework, the Government has mainly formulated safeguard measures for PWD by focusing on four aspects, specifically; support for the employment of PWD; remote interactive decision making; the establishment of a fair vaccine system; and economic protection.

Support the Empowerment of People With Disabilities

The disability group includes multiple sub-groups such as the blind, deaf and intellectually disabled. They have a variety of unique lifestyles and community cultures that are based on their disability characteristics, which makes it difficult for PWD and non-disabled people to understand each other (29). The majority of decision-making bodies are usually made up of non-disabled persons, and this gap between groups is therefore likely to result in the perspectives of disabled people being insufficiently incorporated into relevant systems and legislation. In public health emergencies (PHE), this "blind spot" at the institutional level can be fatal for PWD (9). When the existing system struggles to adjust quickly in PHE, the empowerment of the disabled becomes necessary.

Empowerment is a process that enables people, in their own lives, their communities and their society, to actively address issues they view as important (30). Disability empowerment seeks to enhance the strength of PWD in key elements such as politics,

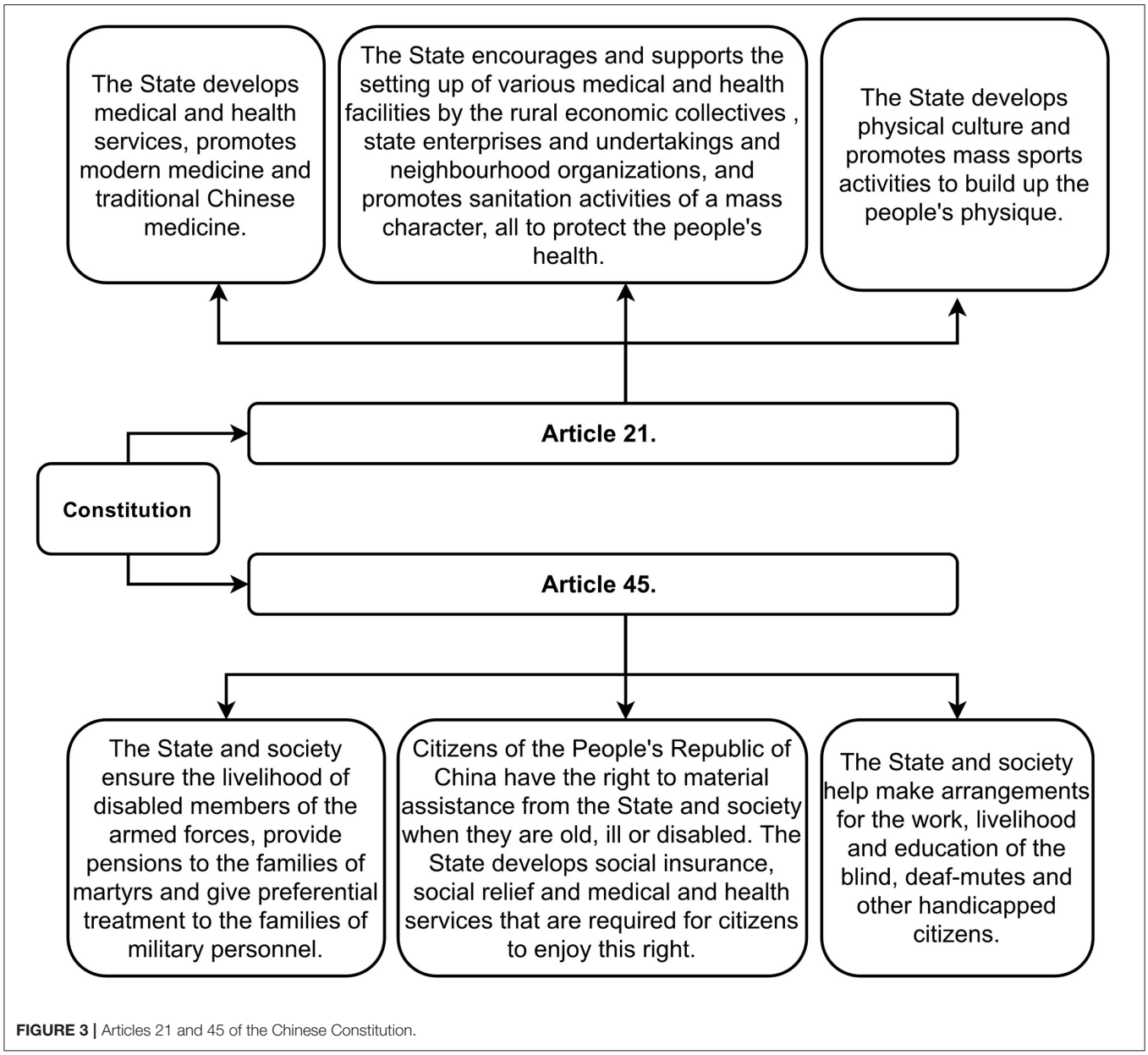

FIGURE 3 | Articles 21 and 45 of the Chinese Constitution.

psychology and physiology, and it achieves this by optimizing systems and education and promoting employment in a way that helps to sustain equal participation in social activities and management. This means that empowered PWD have a stronger ability to organize, manage and protect themselves during PHE. At a time when pandemic prevention consumes a substantial amount of the government's administrative and human resources, the independence produced by disability empowerment gains an added importance and significance.

Like most advanced countries, China has always been devoted to disability empowerment, and has therefore sought to provide support and convenience that enables PWD to be employed, become educated and socially participate to the greatest possible extent (31). But China's most important innovation in this area is its "full-time committee system of persons with disabilities," which requires that every block, community or village must select a full-time committee member of PWD from its disabled residents, and only PWD have the right to vote. People with severe intellectual disabilities or other severely disabled persons can be selected by their immediate family members, who put them forward as candidates. The salaries and social insurance funds of the full-time PWD members are provided by the state.

The main responsibilities of the full-time committee members include (32):

① Investigating the conditions that PWD live in and the challenges they face in their respective jurisdictions; and summarizing their appeals and submitting them to the State authorities.

② Organizing PWD in their respective jurisdictions so that they can participate in recreational and sports activities.

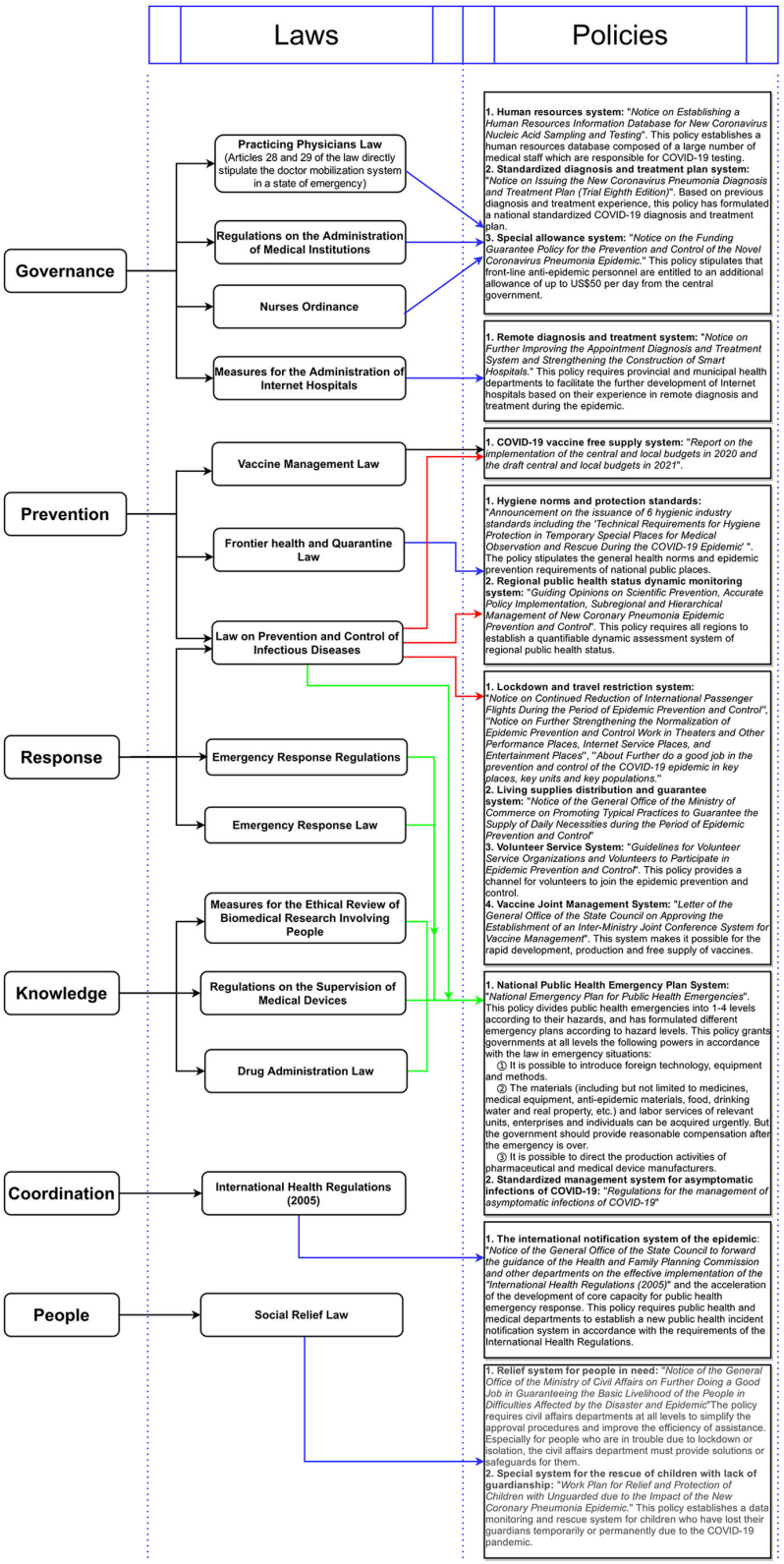

FIGURE 4 | China's public health policy and legislative framework.

③ Liaising with volunteer organizations, non-profit organizations and relevant authorities to support PWD.

④ Supervising the implementation of preferential policies for PWD and helping the Government to distribute materials to PWD.

⑤ Establishing a network that includes all PWD in their respective jurisdictions.

The China Disabled Persons' Federation initially explored and established this system with the support of the central government in 2014. The original intention of the system was to help unify PWD in each community into a mutual help group; this, it was anticipated, would enhance their power and enable them to live with more dignity (33). The full-time PWD members have therefore actually encouraged disabled persons in their jurisdictions to form small autonomous bodies, where they establish contact networks and organize group activities, and this in turn enables them to collectively express their demands and effectively enhance their autonomy and independence. The autonomous nature of the Commission meant that, although the Government provided funds for full-time members, no Government officials or non-disabled persons actually joined.

In an unexpected development, the empowered disability group did not only enable members to protect themselves, but also enabled them to provide support to others. For example, the blind Mr. Xu, a volunteer, led the dispatch of more than $1 million in emergency supplies during the most difficult period in Wuhan, and also contacted helicopters who conducted 13 "sorties" that delivered supplies to the city (34). After the disabled community showed its power, the Government began to welcome more PWD, including full-time members, to participate in epidemic prevention on a voluntary basis (35).

Establish a Remote Interactive Decision-Making System

In the field of administrative decision-making, interactive decision making (IDM) refers to the authorities' use of seminars, group discussions and many other techniques to find innovative and supportive solutions to existing problems (36). Studies show that, when addressing risky choices, groups make fewer decision-making mistakes than individuals (37), and are more likely to make faster and better decisions in uncertain environments (38). IDM has therefore become a common practice in administrative decision-making and it is also applied across all levels of government (39). But the urgency of public health emergencies (PHE) usually requires the authorities to make emergency decisions quickly, so as to avoid a rapid escalation of the crisis. For example, in the COVID-19 pandemic, after a team of medical experts determined that COVID-19 could be transmitted from person to person, China's central government imposed a lockdown on the Wuhan, the outbreak epicenter, and its population of 12.33 million was therefore confined indoors in just 72 h. The rapidity of this process made it difficult for the authorities to fully interact with communities in the decision-making stage, and the social isolation caused by epidemic prevention further limited the realization of IDM. PWD and the non-disabled struggle to understand each other in the best of circumstances, and emergency decision-making is likely to further exacerbate mutual miscommunication and misunderstanding.

Chinese PWD mainly participate in decision-making by being invited to key meetings that take place every day. During the COVID-19 pandemic, this mode of became both risky and inefficient. The diversity of the disabled community also meant that many problems that arose during the pandemic were difficult to predict in advance. Remote Interactive decision-making system (RIDM) is an interactive decision-making participation model that the Government applies in an emergency: When PWD realize that there are problems with the relevant decision-making, or require the authorities to make decisions that resolve difficulties faced by PWD, they can call the hotline and submit a request. This is a "decision starter." The hotline will then transfer the appeals of PWD to the agency that has the authority to make relevant decisions. Officials will then speak to PWD on the phone and will try to quickly develop a solution. Here PWD are "decision-making participants." In order to prevent relevant needs from being overlooked and/or put to one side, the authorities will ask each "decision starter" if they had received an effective response, and the feedback will then be used in departmental evaluations.

The difference between RIDM and complaint calls is that the latter usually only address the complainant's individual needs; however, the decision made by RIDM can solve all similar problems in relevant jurisdictions.

This RIDM system, which even continuing functioned during January 23–April 8, 2020, the most difficult lockdown period in Wuhan, enabled the authorities to effectively respond to urgent needs. When Wuhan Hospital was overwhelmed by the COVID-19 pandemic, a mutual group of disabled people decided to work with the authorities to establish a temporary supply chain of immunologic agents through the RIDM system. This enabled 500 members of the mutual aid group to obtain immune preparations that the hospital had an exclusive right to supply through a specific pharmacy. As a result, they survived (24). Other patients in Wuhan who need immune preparations can also benefit from this policy.

Fair Distribution of Vaccines

The generally disadvantaged position of PWD in society means that they require a more equitable vaccine distribution framework to be put in place. Evidence from the United States and Australia shows that disability and the degree of disability are just two factors that affect the likelihood of citizens getting the flu vaccine, and PWD get fair access to vaccination (40, 41). Other related factors include the prejudice of medical staff and travel barriers caused by disability (42, 43), and separate factors include a shortage of vaccines or socioeconomic barriers (44, 45). Although in other countries, such as the US (46), it is acknowledged that the COVID-19 vaccine should be allocated preferentially to disadvantaged groups such as PWD. However, in the case of the US, this has not been achieved.

The overall vaccination rates for PWD in the United States is 4% lower than for non-disabled people, and this gap further widens to 5.3% when the age group 65 years or older is considered (47).

The Chinese government sought to achieve fairness in vaccine distribution in a number of ways. First, by working to solve the problem of vaccine shortage. China was one of the first countries in the world to successfully develop a COVID-19 vaccine (48), and it has rapidly increased its production capacity. On July 16, 2021, the Ministry of Industry and Information Technology of China announced that China's annual output of COVID-19 vaccine has reached 5 billion doses, it would basically ensure the full supply of vaccines for all of China's population (49). In the period mid-March-July, 2021, China vaccinated more than 2 billion people and exported more than 700 million doses of COVID-19 vaccine and stock solution (50). This has meant that China's public health authorities have not even needed to raise the issue of whether to prioritize the distribution of vaccines to disadvantaged groups such as PWD.

Second, the Chinese government has decided to provide free COVID-19 vaccination services to all residents of mainland China (including foreign residents) (51), meaning that vulnerable groups, including PWD, do not have to pay about $30 (USD) for a vaccine dose (52), and this means their economic worries are removed.

The sufficient supply of vaccines means that PWD can decide when to go to the nearest community epidemic prevention station and receive vaccination. However, some community epidemic prevention stations have not completed barrier free transformation, and this is a major barrier for PWD with travel obstacles. China therefore also sought to eliminate the travel barriers of PWD and the possibility of discrimination as a result of cumbersome medical procedures by quickly converting a number of large buses into vaccination vehicles with barrier-free facilities that then directly provided vaccination services to PWD in their own communities (53).

Door-to-door vaccination services are also an effective community response to PWD with serious travel obstacles (54).

But it must be remembered that are still some people in China (Including some PWD) who are unwilling to receive the COVID-19 vaccine. Previous studies suggest this may be due to complacency or concerns about the safety of vaccines (55). At present, China still adheres to the policy of voluntary vaccination, meaning that the authorities have to rely on persuasion and the force of scientific evidence (56). The Government has also distributed some small gifts, such as a bucket of edible oil or a bag of flour, to those who have been vaccinated at epidemic prevention stations (57).

PROVIDE REASONABLE FINANCIAL PROTECTION TO PEOPLE WITH DISABILITIES IN THE PANDEMIC

In the COVID-19 pandemic, long-term and strict social blockade may result in some low-income people completely losing their financial savings. When this happens, they are more willing to break the blockade and go out to find jobs and food (58). Members of the disability group often have low incomes (59), meaning they will be more economically impacted by the pandemic. For example, in China, the blind most often makes a living by providing massage services. But the blind masseur cannot avoid long-term close contact with customers, meaning that he/she was forced to suspend their work during the social blockade. Rent and wages still have to be paid, and this has pushed many blind massage shops closer to bankruptcy.

The Chinese government responded by developing an economic security plan that would assist this particular disadvantaged group. In Hainan Province, for example, the Taxation Bureau reduced or exempted the taxes paid by blind massage shops and blind employees, and also allowed them to defer tax payment. Second, the shops that rented state-owned properties (many properties in Chinese cities belong to the state) were not required to pay 3 months of rent during the social lockdown. Finally, in responding to the cash flow difficulties, the Hainan Disabled Persons' Federation obtained an unconditional economic subsidy of nearly 1,000,000 Yuan (∼$150,000) from the provincial government that was then distributed to 114 blind massage shops in the province (60). In responding to the economic difficulties experienced by other persons with disabilities, such as the deaf and mentally impaired, the Chinese government and disability rights organizations jointly formulated a similar economic security plan. The central government addressed the needs of extremely poor disabled persons who have no source of income at all by stipulating that civil affairs departments across all levels are responsible for ensuring that they sustain a basic standard of living during the epidemic prevention period (61).

DISCUSSION

This article has shown that the professionalism of decision-makers is extremely important for dealing with PHE. In China's unique political system, the heads of governments and functional departments at all levels are industry experts with knowledge of specific industries rather than career politicians (62). This helps to ensure that China's epidemic prevention policies and legislation are, in most cases, prompt, professional, and effective (63). For example, in Hainan Province, where none of the 500,000 disabled residents was infected with COVID-19, the top leader, SHEN Xiaoming, is not only a well-known medical expert in China (64), but is also an Honorary Fellow of American Academy of Pediatrics and Foreign Associate of the U.S-based Institute of Medicine of National Academies (65). His professional background was an invaluable resource that the local authorities were able to draw on as they sought to make correct judgments on various types of PHE, and to optimize the province's public health policies and local legislation in a targeted manner. This is very important for PWD who are less able to resist risks.

Second, China's experience also shows that interaction in the decision-making process is important for PWD. This group has low education levels and economic status (26), and this limits their ability to participate in politics (66), meaning they do not

generally exert great influence over decision-making in various countries, including American (67), the United Kingdom (68), and Norway (69). This means the needs of PWD can hardly be included in the emergency response of countries in the early stages of the pandemic. But in reflecting on their own failure to contain the pandemic, affected countries should refer to China's experience and consider how to maintain interaction with the disabled community during the public health policy formulation and legislation process.

Third, we should also pay attention to the positive effects of high social capital on PWD-focused responses to the COVID-19 pandemic. Social capital is an instantiated informal norm that can promote cooperation between individuals (70). In a pandemic, it determines if comply with laws and regulations (71). Research shows that social distancing measures are more decisive and more efficient in areas that have higher levels of social capital (72). People will also work together to comply with government regulations and guidelines if they are self-motivated. In the case of PWD, the experiences of the Wuhan mutual aid group for PWD and the full-time Committee of PWD proves that high levels enable disabled communities to maintain their close ties with each other and the wider society during the COVID-19 pandemic. In addition to significantly improving the self-protection ability of disabled communities during the COVID-19 pandemic, this reduces the risk of PWD being marginalized during the pandemic and provides them with psychological support. However, the discussion should be supplemented by an acknowledgment of studies that suggest that strong family relationships and social gatherings that produce high social capital may become a risk during a pandemic (73). Evidence from Northeastern China shows that most clustered cases in this area occurred in individual families and/or between relatives. This negative effect of social capital should also be acknowledged (74).

In addition, political observers need to consider how to adjust their policies and legislation in order to further prevent PWD from being affected by healthcare discrimination in epidemic prevention. In this article, we find that general shortages of medical resources caused by the pandemic may result in an increased risk that PWD will be discriminated against. Although, we do not ground this claim in evidence collected from the Chinese medical system, it should be noted that Brazil, India, South Korea, Turkey and South Africa have reported that PWD are at high risk of experiencing healthcare discrimination during the pandemic (75–79). Evidence from the American also shows that PWD may be disadvantaged by discriminatory medical rationing when medical resources are scarce (11). In addition, the uneven availability of public health information, which is frequently evidenced in different countries, may also contribute to healthcare discrimination against PWD (80). The above evidence therefore suggests that healthcare discrimination faced by PWD may be a worldwide problem, and all countries need to acknowledge and address this issue.

The fact that China has already begun to raise a question about the fact of this process, that is, whether its example can be imitated or replicated. On the basis of the findings of this article, we reject this proposition, and propose that it should be a point of reference. The foremost consideration in this regard is the unique character of the Chinese political system: unlike the "night watch government" (81) in many countries, which only provides core government functions such as national defense, internal security and prison management, the Chinese government is an engaged "big government," meaning that it can and is willing to coordinate, exert power and deploy all available domestic resources effectively, and quickly impose necessary restrictions on social activities. Since the early 1980s, various governments, of different stripes and colors, have declared the demise of big government to be "over" (82). However, the political tide will perhaps now turn because both the ongoing pandemic and China's previous experience of fighting swine fever (83) suggest that this form of government has clear comparative institutional advantages in PHE. This feature has, in the view of the authors, been insufficiently acknowledged as a key factor in East Asia's current status as a world leader (84) in the fight against the pandemic. Other factors, including China's abundant human resources and strong industrial production capacity, should also be taken into account, as they have enabled the Chinese government to take prompt measures. We anticipate that when other countries try to replicate China's epidemic prevention experience, they will inevitably encounter shortages of human resources and industrial production capacity, along with severely insufficient government authority.

Finally, we need to acknowledge that the situation of PWD in public health data is still unclear (85). In 2016, some scholars asserted that disability should be counted in public health statistics, and this view grew stronger after the COVID-19 pandemic (86). Our research suggests that too few medical and public health institutions record the disability status of COVID-19 infected persons in statistical data, and we also noted how this has hindered the development of national disability policy and the work of legal researchers during the COVID-19 pandemic (87). We would therefore like to reiterate our request for medical and public health institutions to track disability indicators in statistical data.

CONCLUSION

In summary, China has taken a series of effective measures to protect the health of PWD during the COVID-19 pandemic, and its efforts have been considerably aided both by its own national conditions and institutional advantages. Although many of China's specific measures may be difficult to replicate in other countries, we would suggest that other countries should reflect on the measures that the Chinese national government put in place to address the special needs of the disabled group and the specific obstacles that confronted it. Working on the assumption that humans will ultimately have to coexist with COVID-19 (88), we propose that international communities should focus on how to get countries to more closely consider the difficult situation of PWD in PHE, and also explore and construct response plans

that are based on their respective national conditions and institutional advantages.

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

FQ, YW, and QW contributed to conception and design of the study and wrote sections of the manuscript. FQ performed the statistical analysis and wrote the first draft of the manuscript. All authors contributed to manuscript revision, read, and approved the submitted version.

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A Cross-Sectional Survey on COVID-19 Vaccine Hesitancy Among Parents From Shandong vs. Zhejiang

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Introduction: With the approval of COVID-19 vaccinations for children and adolescents in China, parental vaccine hesitancy will emerge as a new challenge with regard to the administration of these vaccines. However, little is known regarding this hesitancy as well as regional differences that may exist between parents from Shandong vs. Zhejiang.

Methods: To assess these issues, an online survey was conducted via a Wenjuanxing platform over the period from July 22 to August 14, 2021. Parents from Shandong and Zhejiang were recruited from Wechat groups and results from a total of 917 subjects were analyzed. Factors evaluated in this survey included socio-demographic variables, parental vaccine hesitancy, Parental Attitudes toward Childhood Vaccines (PACV) domains (behavior, safety and efficacy, general attitudes) and social support.

Results: Compared with those from Shandong ($N = 443$), parents from Zhejiang ($N = 474$) showed significantly higher prevalence rates of COVID-19 vaccine hesitancy (19.4 vs. 11.7%, $p = 0.001$). Multivariate logistic regression showed that yearly household incomes of ≥120,000 RMB ($p = 0.041$), medical workers ($p = 0.022$) and general attitudes of PACV ($p = 0.004$) were risk factors for vaccine hesitancy among parents from Shandong, while behavior ($p = 0.004$), safety and efficacy ($p < 0.001$) and general attitudes of PACV ($p = 0.002$) were risk factors for parents from Zhejiang. Among parents with vaccine hesitancy ($N = 144$), concerns over side effects (91.0%) and unknown effects (84.0%) of the COVID-19 vaccine were the most prevalent reasons for hesitancy. Evidence providing proof of vaccine safety (67.4%) and assurance of a low risk of being infected by COVID-19 (60.4%) were the two most effective persuasive factors.

Conclusion: Parents from Zhejiang showed a higher prevalence of COVID-19 vaccine hesitancy as compared with those from Shandong. Behavior, safety and efficacy, and general attitudes of PACV were the risk factors associated with this hesitancy in these parents from Zhejiang. Given the identification of the various reasons for parental vaccine hesitancy, different strategies as well as regional adjustments in these strategies will be required for an effective and convincing protocol for childhood vaccinations.

Keywords: COVID-19, parental vaccine hesitancy, PACV, Shandong, Zhejiang

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INTRODUCTION

In July 2021, China announced that children and adolescents aged 3–17 could receive COVID-19 vaccinations (1). This announcement immediately evoked widespread attention and responses from the public, in particular parents. While vaccinations have the potential of protecting children from the COVID-19 infection and harm, some parents were hesitant for their children to be vaccinated (2, 3). In fact, this hesitancy was escalating despite findings from previous reports demonstrating that vaccinations against many major diseases have saved millions of children from death every year worldwide (4, 5). With this approval of COVID-19 vaccination for children and adolescents in China, parental vaccine hesitancy has become the focus of considerable attention and debate.

Vaccine hesitancy refers to the delay in acceptance or refusal of vaccination despite the availability of services (6). The WHO listed vaccine hesitancy as one of the top 10 global threats to health in 2019 (7). The phenomenon of vaccine hesitancy is the result of a number of complex and context specific factors, which are affected by issues such as confidence, complacency and convenience (6). According to findings from previous reports, issues of confidence refer to a lack of trust in the safety and effectiveness of the vaccine as provided by health care or government agencies (8, 9), those of complacency refer to perceptions which dismiss the value of the vaccination or necessity for vaccination (10), while those of convenience refer to difficulty in access for the vaccination. It has also been reported that social support from family, friends, colleagues and the community may be a beneficial factor for enhancing confidence (11). Importantly, understanding the reasons for parental vaccine hesitancy and developing strategies to address these issues are essential for an effective promotion of childhood and adolescent vaccinations.

As two of most populous provinces in Eastern China, Shandong and Zhejiang represent two critical regions regarding the focus of childhood and adolescent COVID-19 vaccination efforts (12). Accordingly, parents who hesitate to vaccinate their children, along with their reasons for this hesitation in these regions represent key samples of perceptions requiring attention that can likely be applicable throughout all of China, if not the world. However, only a very limited number of reports have been directed toward this issue of Chinese parental COVID-19 vaccine hesitancy for their children (13), to our knowledge, no research on this topic exists for parents from Shandong and Zhejiang provinces. Therefore, in this report an online survey on parental hesitancy from Shandong and Zhejiang provinces was conducted. With this survey, it was possible identify factors contributing to the prevalence and reasons for COVID-19 vaccine hesitancy, as well as any potential regional differences which may be present in this hesitancy.

MATERIALS AND METHODS

Design, Subjects, and Procedure

This was a cross-sectional study performed via an online survey conducted over the period from July 22 to August 14, 2021. This study was performed a week after the Chinese government approved nationwide COVID-19 vaccinations for children and adolescents aged 3–17. With these vaccinations, public health officials suggested that the guardians of these children and adolescents provide informed consent and accompany them throughout the vaccination process (1).

From the 16 cities in Shandong Province, four cities were selected at random (Jinan, Yantai, Dongying, and Jining), and three cities were selected from the 11 cities in Zhejiang Province at random (Hangzhou, Jinhua, and Ningbo). One children and youth education center from each of these seven cities was randomly selected for this survey. To facilitate unified management, all education centers possessed their own WeChat groups, which included parents of all children. All the participants in the survey came from those WeChat groups.

Parents ($\geq$18 years) from Shandong and Zhejiang were encouraged to participate in this online survey via a Wenjuanxing platform (https://yuyue.wjx.top/vj/OL0Dnum.aspx), which was issued on WeChat groups. This online survey contained a series of questions directed at acquiring information on socio-demographic data, clinical variables and parental willingness of vaccination against COVID-19 for their children. In order to ensure questionnaire quality, a math question (93–7 = ?) was included at the end of the survey to reduce the risk of irresponsible answers. The platform alerted participants of unanswered questions when they submitted their survey responses. This study was approved by the Medical Ethics Committee of the Dongyang Hospital affiliated to Wenzhou Medical University.

Measurements

Demographic Data

Age, sex, marital status (married vs. single), education level $\leq$9 years (junior high school and lower) vs. $>$ 9 years (senior high school and higher), working status (employed, unemployed), occupational classification (medical vs. non-medical workers), number of hours worked per day, yearly household income ($<$30,000 RMB, 30,000–120,000 RMB or $\geq$120,000 RMB), residence (urban vs. rural), and number of children raised (1 vs. $\geq$2) were collected from the questions of the online survey. Participants were also asked to provide information on the following additional issues: whether your children had a history of COVID-19 infection, vaccinations in the past 3 years, and adverse effects of vaccinations, whether family members had a history of COVID-19 infection and whether you attended any lectures about COVID-19 vaccination.

Parental Vaccine Hesitancy

Our primary determination was to assess parental vaccine hesitancy, as achieved by asking participants: "If a COVID-19 vaccine was available for your children, would you like them to get it?". Those responding "no" or "uncertain" were defined as demonstrating vaccine hesitancy. These respondents were then asked: "What are the main reasons you would not allow the vaccine for your children?", with respondents being required to select at least one main reason as contained in a list of 10 possible answers (**Figure 1**). They were also asked: "Which strategies

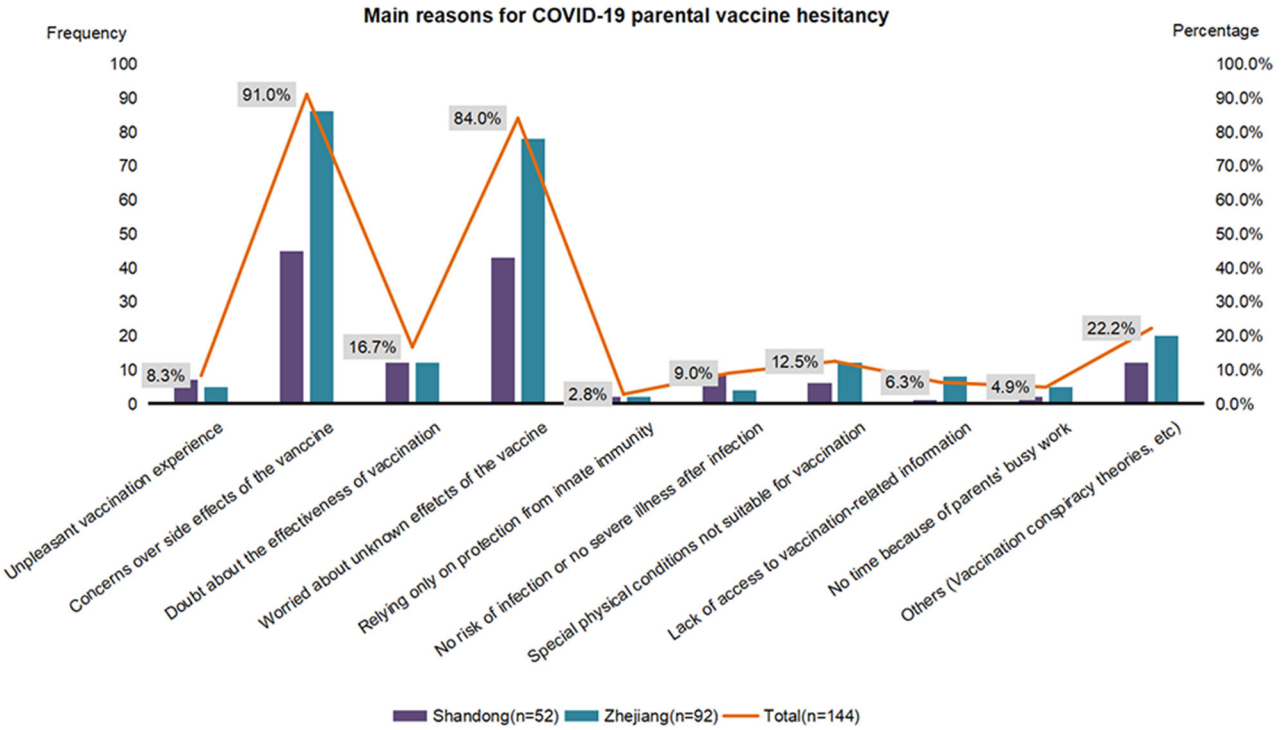

FIGURE 1 | Main reasons for parental COVID-19 vaccine hesitancy in Shandong ($N = 52$) and Zhejiang ($N = 92$). COVID-19—the coronavirus disease 2019.

would increase the chances of you choosing the vaccination for your children?", and were provided with a list of 9 possible answers for this question (**Figure 2**).

Parental Attitudes Toward Childhood Vaccines (PACV) Scale

The Parental Attitudes toward Childhood Vaccines (PACV) scale is a 15-item self-report tool, which can assess the behavior or attitude (doubts or concerns) associated with parental vaccine hesitancy. It is comprised of three domains, behavior (2 items; total scale scores ranging from 0 to 4), safety and efficacy (4 items; total scale scores ranging from 0 to 8) and general attitudes (9 items; total scale scores ranging from 0 to 18). Item scores were summed in an unweighted fashion to obtain a raw total score of 30. Higher scores for each domain indicate decreasing interests/perceptions regarding vaccination behavior or attitude.

Social Support Assessment

The Social Support Rating Scale (SSRS) is a 10-item self-report instrument to assess the level of individual social support in the last year. It was comprised of three subscales, objective support (items 2, 6, and 7), subjective support (items 1 and 3–5), and utilization of support (items 8–10). Objective support refers to direct, realistic and visible support. Subjective support refers to the perception of social support experienced whereby the individual feels the support, help and care from family, friends and colleagues. The utilization of support incarnates the level of social support. Higher scores for each subscale suggest a higher level of social support.

Statistical Analyses

Data analyses were performed with use of the IBM SPSS Statistical Software program (version 19). All hypotheses were tested at a significance level of 0.05. χ^2 tests or Fisher exact tests were used for categorical variables. Mann-Whitney *U*-tests were used to compare independent groups on continuous variables lacking a normal distribution. Subgroup analyses were performed for Shandong and Zhejiang parents.

Parental COVID-19 vaccine hesitancy was used as a dependent variable, while independent variables were: age, sex, marital status, working status, occupational classification, education level, number of hours worked per day, residence, yearly household income, number of children raised, history of children's COVID-19 infection, vaccination in the past 3 years, adverse effects of any vaccinations, a history of COVID-19 infection in family members, attendance at COVID-19 vaccination lectures, SSRS (i.e., objective, subjective, or utilization of support) and PACV domains (behavior, safety and efficacy, and general attitudes). There is no linear relationship between parental vaccine hesitancy and the independent variables. Multivariate logistic regression analyses were performed using stepwise variable selection with all variables entered into the model to evaluate the independent influence of COVID-19 vaccine hesitancy among Shandong and Zhejiang parents.

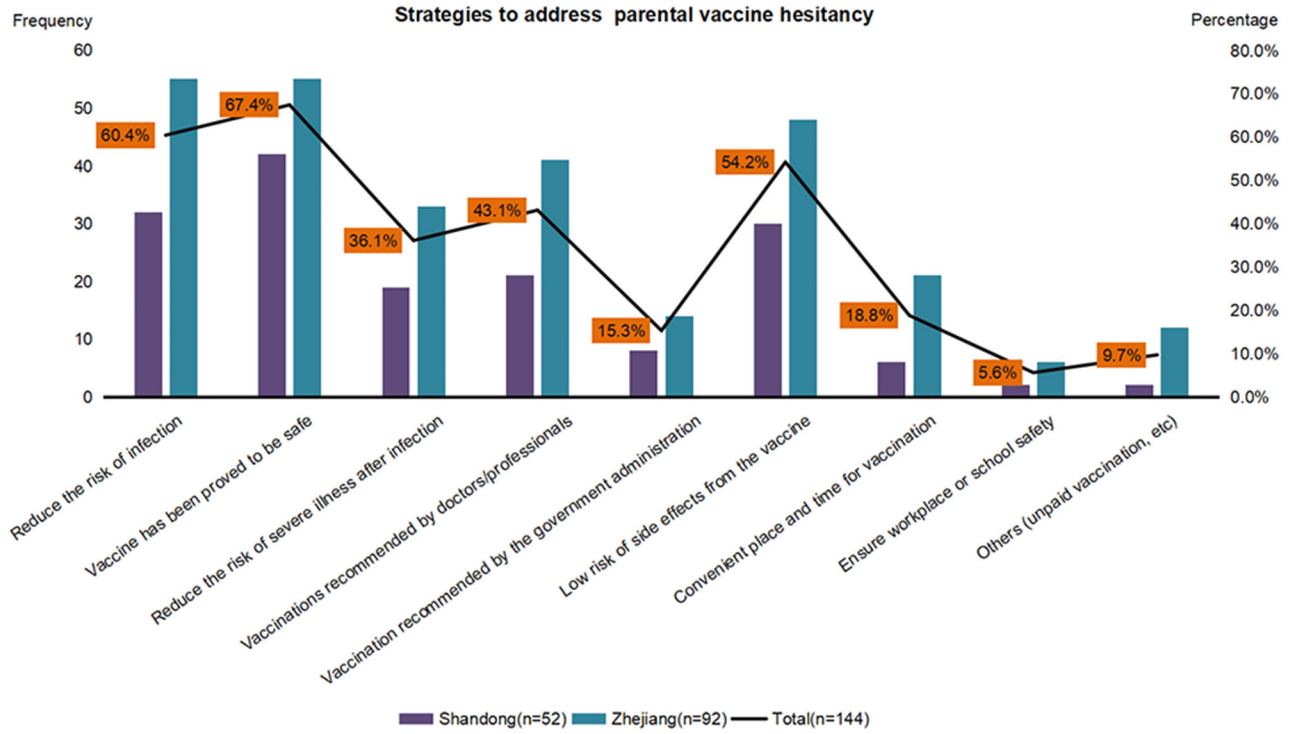

FIGURE 2 | Strategies to address parental COVID-19 vaccine hesitancy in Shandong ($N = 52$) and Zhejiang ($N = 92$). COVID-19—the coronavirus disease 2019.

RESULTS

A total of 923 parents were contacted to participate in the online survey. Of these, results from 917 were analyzed, with subjects who failed to correctly answer the math question (6.50‰) being excluded.

Table 1 contains the socio-demographic characteristics of the respondents from Shandong ($N = 443$) vs. Zhejiang ($N = 474$) province. Parents from Zhejiang showed higher prevalence rates of COVID-19 vaccine hesitancy compared with those from Shandong (19.4 vs. 11.7%, $p = 0.001$). Parents from Shandong had higher rates of >9 years of education ($p < 0.001$), while those from Zhejiang had longer daily working hours ($p < 0.001$). Respondents from Zhejiang were more likely to live in rural areas ($p = 0.024$) and have more than one child ($p < 0.001$). Parents from Zhejiang had higher scores for the categories of safety and efficacy ($p < 0.001$), general attitudes ($p < 0.001$), subjective support ($p < 0.001$) as well as higher total PACV scores ($p < 0.001$) than those from Shandong. Statistically significant differences between Shandong and Zhejiang were also observed with regard to children's vaccination history in the past 3 years ($p = 0.001$), past adverse effects of children's vaccinations ($p = 0.017$), and behaviors of PACV ($p < 0.001$).

Results of the multivariate logistic regression analyses (**Table 2**) revealed that yearly household incomes ≥120,000RMB (odds ratio [OR], 3.76, 95% confidence interval [CI], 1.05–13.42; $p = 0.041$), medical workers (OR, 3.57; 95% CI, 1.20–10.62; $p = 0.022$) and general attitudes of PACV (OR, 1.37; 95% CI, 1.10–1.71; $p = 0.004$) were risk factors for vaccine hesitancy among parents from Shandong, while behavior (OR, 1.58; 95% CI, 1.16–2.17; $p = 0.004$), safety and efficacy (OR, 1.29; 95% CI, 1.13–1.46; $p < 0.001$), and general attitudes (OR, 1.23; 95% CI, 1.08–1.41; $p = 0.002$) of PACV, were risk factors for parents from Zhejiang. Protective factors for vaccine hesitancy in parents from Shandong were female (OR, 0.43; 95% CI, 0.22–0.86; $p = 0.016$) and ≥2 children raised (OR, 0.38; 95% CI, 0.18–0.83; $p = 0.015$), while for parents from Zhejiang, two protective factors included rural residence (OR, 0.53; 95% CI, 0.31–0.93; $p = 0.026$) and ≥2 children raised (OR, 0.53; 95% CI, 0.28–0.97; $p = 0.040$).

The main reasons why parents (52 respondents from Shandong and 92 from Zhejiang) were hesitant to vaccinate their children are summarized in **Figure 1**. Concerns over side effects of the COVID-19 vaccine (91.0%) and unknown effects (84.0%) were the most prevalent reasons, followed by doubt regarding the effectiveness of the vaccination (16.7%). As shown in **Figure 2**, when asked which factors would increase the chances of their children's vaccination, 67.4% of all parents expressing a hesitancy for vaccination reported that they would have their children vaccinated if the vaccine was proven to be safe, while 54.2% would vaccinate their children if there was an assurance for a low risk of side effects from the vaccine. Reducing the risk of COVID-19 infection was another effective persuading factor for 60.4% of the parents.

TABLE 1 | Socio-demographic characteristics of parents from Shandong vs. Zhejiang province.

Characteristics	Total ($n = 917$)	Shandong ($n = 443$)	Zhejiang ($n = 474$)	*p*
COVID-19 vaccine hesitancy	15.7 (144)	11.7 (52)	19.4 (92)	0.001
Age, years	36.98 ± 5.85	37.28 ± 4.19	36.69 ± 7.05	0.263
Male, sex	32.5 (298)	34.1 (151)	31.0 (147)	0.321
Married	93.2 (855)	92.6 (410)	93.9 (445)	0.422
Educational level >9 years	52.1 (478)	62.1 (275)	42.8 (203)	<0.001
Employed	85.6 (785)	86.9 (385)	84.4 (400)	0.277
Medical workers	6.2 (57)	6.1 (27)	6.3 (30)	0.883
Time worked per day, h	8.72 ± 2.47	8.45 ± 1.97	8.97 ± 2.85	<0.001
Household income per year, RMB				0.415
<30,000	26.8 (246)	25.1 (111)	28.5 (135)	
≥30,000 and <120,000	53.2 (488)	58.9 (261)	47.9 (227)	
≥120,000	20.0 (183)	16.0 (71)	23.6 (112)	
Living areas				0.024
Urban	40.7 (373)	44.5 (197)	37.1 (176)	
Rural	59.3 (544)	55.5 (246)	62.9 (298)	
Number of children raised ≥2	71.5 (656)	63.9 (283)	78.7 (373)	<0.001
COVID-19 infection history of the child	0.3 (3)	0 (0)	0.6 (3)	0.094
COVID-19 infection history of family member	1.2 (11)	1.6 (7)	0.8 (4)	0.306
Children's vaccination history in the past 3 years	43.6 (400)	49.2 (218)	38.4 (182)	0.001
Past adverse effects of children's vaccinations	1.4 (13)	0.5 (2)	2.3 (11)	0.017
Attended lectures about COVID-19 vaccinations	30.5 (280)	32.7 (145)	28.5 (135)	0.163
PACV				
Behavior	0.39 ± 0.73	0.46 ± 0.71	0.32 ± 0.73	<0.001
Safety and efficacy	2.76 ± 2.05	2.46 ± 1.97	3.04 ± 2.09	<0.001
General attitudes	6.83 ± 1.98	6.62 ± 1.74	7.02 ± 2.16	<0.001
Total score	9.98 ± 3.28	9.55 ± 3.09	10.38 ± 3.41	<0.001
SSRS				
Objective support	7.76 ± 2.73	7.81 ± 2.52	7.71 ± 2.91	0.333
Subjective support	25.67 ± 3.79	25.30 ± 3.20	26.01 ± 4.25	<0.001
Utilization of support	7.34 ± 2.20	7.22 ± 2.28	7.45 ± 2.13	0.125
Total score	40.76 ± 6.68	40.33 ± 6.44	41.16 ± 6.88	0.081

Values are presented as means ± SD or percents (n). χ^2 tests or Fisher exact tests were used for group differences of categorical variables, and Mann-Whitney tests for continuous variables. COVID-19, the coronavirus disease 2019; PACV, Parental Attitudes toward Childhood Vaccines; SSRS, Social Support Rating Scale.

DISCUSSION

From this inaugural study on parental COVID-19 vaccine hesitancy as conducted in Shandong and Zhejiang provinces, a number of novel findings emerge. First, parents from Zhejiang had higher prevalence rates of COVID-19 vaccine hesitancy for their children as compared with those from Shandong. Second, behavior, safety and efficacy and general attitudes of PACV were risk factors for vaccine hesitancy among parents from Zhejiang, while yearly household incomes of ≥120,000 RMB, medical workers and general attitudes of PACV were risk factors for parents from Shandong. Third, of the main reasons for this parental hesitancy, concerns over side effects and unknown effects of the COVID-19 vaccine were the most prevalent reasons. By contrast, evidence in support of the safety for the COVID-19 vaccine was the most effective persuasive factors. These findings, offer the first data which can serve as a basis for public health strategies to diminish parental vaccine hesitancy in Shandong and Zhejiang provinces and thus increase COVID-19 vaccinations within children and adolescents.

Parental vaccine hesitancy represents a daunting problem in many countries worldwide and will significantly impact the promotion of childhood and adolescent vaccinations against the COVID-19 (14, 15). Although these COVID-19 vaccines are readily available and there exists considerable evidence indicating the effectiveness, safety and extremely low risks of side effects (16, 17), some parents throughout China remain hesitant with regard to the vaccination of their children (13, 18). Although the COVID-19 vaccination rate in Chinese adults reached more than 75% in mid-September 2021, there was a recent COVID-19 outbreak in Fujian. Worryingly, unlike previous epidemics, a large number of children were reported to be infected in this Fujian epidemic (19). In this harsh current situation, only by increasing the coverage of the vaccination

TABLE 2 | Multivariate conditional logistic regression analysis of parental vaccine hesitancy risk in Shandong and Zhejiang provinces.

Variables	OR (95%CI)	*p*
Shandong		
Female	0.43 (0.22, 0.86)	0.016
Number of children raised ≥2	0.38 (0.18, 0.83)	0.015
Household income per year ≥120,000 RMB	3.76 (1.05, 13.42)	0.041
Medical workers	3.57 (1.20, 10.62)	0.022
General attitudes of PACV	1.37 (1.10, 1.71)	0.004
Zhejiang		
Number of children raised ≥2	0.53 (0.28, 0.97)	0.040
Living in rural	0.53 (0.31, 0.93)	0.026
Behavior of PACV	1.58 (1.16, 2.17)	0.004
Safety and efficacy of PACV	1.29 (1.13, 1.46)	<0.001
General attitudes of PACV	1.23 (1.08, 1.41)	0.002
Total		
Employed	2.14 (1.19, 3.85)	0.011
Household income per year ≥120,000 RMB	2.98 (1.52, 5.84)	0.002
Number of children raised ≥2	0.50 (0.33, 0.76)	0.001
Attended lectures about COVID-19 vaccinations	1.67 (1.06, 2.63)	0.028
Behavior of PACV	1.27 (1.00, 1.61)	0.048
Safety and efficacy of PACV	1.21 (1.10, 1.33)	<0.001
General attitudes of PACV	1.24 (1.11, 1.37)	<0.001

OR, odds ratio; CI, confidence interval. Multivariate logistic regression analyses using stepwise variable selection. COVID-19, the coronavirus disease 2019; PACV, Parental Attitudes toward Childhood Vaccines.

for adolescents and children, they can be protected from the harm of the COVID-19. Parental vaccine hesitancy is the main obstacle to COVID-19 vaccination for children, so our study has become particularly important. In our study, 19.4% of parents from Zhejiang showed a vaccine hesitancy for the COVID-19 vaccine, which was significantly greater than that of the 11.7% of parents from Shandong. These levels of hesitancy were lower than those as reported in a previous study on the COVID-19 vaccine hesitancy among parents in Wuxi (13). Our findings suggest that not only does vaccine hesitancy among parents represent a serious issue but that regional differences exist in this hesitancy, which must be taken into account with the promotion of this COVID-19 vaccine.

Our findings also present the potential risk factors associated with this COVID-19 vaccine hesitancy as expressed by these parents from Zhejiang and Shandong. Vaccine hesitancy appears to involve an attitude (doubts or concerns) as well as a behavior (6). Mounting evidence suggests that attitudes, including not valuing or perceiving a need for the vaccination were critical issues underlying vaccine hesitancy (10, 20). Results from a previous report on parental vaccine hesitancy in Shanghai indicated that PACV could serve as a good predictor of parental vaccine hesitancy, due to its capacity to describe concerns about vaccine safety and effectiveness (21). Similarly, in our study, general attitudes, safety and efficacy and behavior of PACV were found to be risk factors for vaccine hesitancy among parents from Zhejiang. Unlike previous studies on parental COVID-19 vaccine hesitancy in China, the three domains of PACV are used as independent variables to predict vaccine hesitancy for the first time in this study (18, 22). In additional, medical workers often expressed concerns about the unknown effects of newly developed vaccines from a long-term perspective, leading to their conservative attitude toward COVID-19 vaccination (23, 24). Thus, it is not difficult to understand why medical workers in Shandong are cautious about vaccinating their children against COVID-19. Obviously, various factors related to issues of confidence and complacency, will contribute to the development of parental vaccine hesitancy. Accordingly, focusing on risk factors contributing to parental vaccine hesitancy will no doubt be critical when promoting use of these vaccinations for children and adolescents.

It is clear that the reasons for parental vaccine hesitancy are complex, varying across time, region and vaccines (6). In our study, concerns over side effects of a COVID-19 vaccine and worries about unknown effects were found to be the most frequent reasons for vaccine hesitancy, separately accounting for ∼90 and 85%, respectively, of parents who were hesitant to get their children vaccinated. Recent researches on the main reasons for COVID-19 vaccine hesitancy reported that most respondents were concerned about future unknown effects and side effects related to vaccines, and some even distrusted vaccines (25, 26). Doubt regarding the effectiveness of this vaccination was another common reason for parental vaccine hesitancy in our study, a factor which was also observed in studies on vaccine hesitancy in other countries (27). Moreover, our findings reported additional reasons for parental vaccine hesitancy that include: beliefs that no risk and/or severe illness will result from this infection, special physical conditions not suitable for vaccinations and time constraints due to parental work schedules. Our current findings on the reasons for parental vaccine hesitancy provide an important new foundation for developing specific strategies in promoting the implementation of this vaccine for use in children and adolescents.

The administration of this COVID-19 vaccine within children and adolescents represents a necessary and crucial undertaking for controlling the spread of the COVID-19 epidemic (28). To accomplish this goal, different strategies should be employed to address parental vaccine hesitancy (29, 30). Of these strategies, the most important will be to disseminate knowledge about the COVID-19 vaccine along with transparent information related to side effects associated with this vaccination. Such information would substantially dispel concerns regarding side effects and build confidence in the safety of the vaccine (31). Moreover, increasing public awareness would highlight the importance of this vaccination and contribute to changes in parental negative attitudes toward childhood vaccinations (32). In this regard, new media and short videos which promote these vaccinations may greatly aid in their acceptance (33). The inception of a free, full coverage COVID-19 vaccination for these children and adolescents as initiated within China in July 2021 should maximize the potential for protection against this epidemic.

LIMITATIONS

This study has several limitations. First, the inadequacies associated with such a cross-sectional design cannot be avoided, and a survey on changes in parental vaccine hesitancy across different periods should be encouraged. Second, the sample size in the survey was relatively small which may, in part, be due to some parents voluntarily opting out of participation in this study. Finally, as it was not possible to identify the characteristics of parents outside the survey, we cannot verify that the participants of this study were representative of all the parents from Shandong or Zhejiang.

CONCLUSION

In the promotion of childhood and adolescent vaccinations against COVID-19, parents from Zhejiang showed a higher prevalence of vaccine hesitancy compared with those from Shandong. Behavior, safety and efficacy, and general attitudes of PACV were risk factors for these parents from Zhejiang. As various reasons exist for parental vaccine hesitancy, multiple strategies should be employed for promoting vaccinations. In particular, strengthening knowledge regarding the safety and importance of the vaccine would greatly help in establishing confidence for this vaccine as administered within children and adolescents.

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 Dongyang People's Hospital, Wenzhou Medical University. The participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

YX and XZ: conception and design. YX, DX, FM, PW, HL, QL, LW, JD, YL, WZ, and XZ: conduction. LL: statistical analysis. YX, DX, FM, PW, HL, QL, and XZ: administrative, technical, or material support. YX and XZ: drafting of the manuscript. XZ: critical revision of the manuscript for important intellectual content. All authors read and approved the final paper.

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REVIEW
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Challenges and Approaches of the Global Governance of Public Health Under COVID-19

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Public health events, as the common concern faced by the international community, call for the joint response from all mankind. The outbreak of the COVID-19 has highlighted the problems confronting the global governance of international public health, such as limited functions of international organizations and difficulties in achieving objectives, poor collaboration between governance subjects and their limited performance, overlapping legal basis of governance and blurred core function, and lack of solutions to special problems. The corresponding approaches can be taken to improve the efficiency of the governance of global public health, including supporting the role of international organizations to achieve the objectives, enhancing coordination among international governance subjects to form synergy, promoting the compliance with IHR2005 to avoid conflict of law application and upholding the vision of a community with a shared future for mankind to jointly respond to the special problems.

Keywords: COVID-19, IHR2005, PHEIC, global governance, international public health

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INTRODUCTION

In December 2019, COVID-19 emerged and has since spread around the globe, infecting millions and leading to thousands of deaths. COVID-19 is characterized with strong transmissibility, infectiousness in its incubation period and threat to people's health and even life (1). Given the growing number of patients and reports of the epidemic in many countries around the world, the Committee of the World Health Organization (WHO), in accordance with *International Health Regulations (2005)* (IHR2005), agreed that the outbreak meets the criteria for a Public Health Emergency of International Concern (PHEIC) on the evening of 30 January 2020. It is thus clear that PHEIC becomes a global concern because of the growing interdependence of countries across the world in the face of disasters.

As early as the second half of the 19th century, the impact of international public health events had become one of the world's concerns (2). After the Second World War, the UN's Economic and Social Council held an international health conference in New York in July 1946, where the *Constitution of the World Health Organization* was adopted, along with a plan to establish the WHO. WHO, the world's organization to handle international health issues has, since its establishment, played an important guiding and promoting role in the cooperation to tackle international health issues, the prevention and control of infectious diseases, the improvement of theoretical research and practice of biomedicine, the development of health undertakings within member countries, and the improvement of people's health. Health has an intrinsic value to the individual and to the society (3). The preamble to the WHO Constitution embodies this aspiration. The development of society, along with the frequent international economic, trade and personnel

exchanges, has also accelerated the globalization of public health. Public health has emerged as one of the most important issues of our global age. Globalization propels pathogens, placing us at risk (4). For centuries, several beliefs and political ideologies have existed on disease and its transmission (5). For instance, the first recorded smallpox epidemic began in Egypt in 1350 BCE. It reached China in 49 CE, Europe after 700, the Americas in 1,520, and Australia in 1,789. The bubonic plague, or "Black Death," originated in Asia, but it spread to Europe in the fourteenth century, where it killed a fourth to a third of the population. Europeans carried diseases to the Americas in the fifteenth and sixteenth centuries that destroyed up to 95 percent of the indigenous population (6). From the 1980s just to the mid-twenty-first century, 2013–15, there were more than 12,000 major outbreaks of novel diseases, 215 infectious diseases, 44 million cases in 219 countries (4). Never before have public health problems been featured so urgently and comprehensively in the political, economic, and social dynamics of domestic and world affairs (7).

At the beginning of the twenty-first century there is widespread recognition that national and international health are inseparable (8). The COVID-19, in particular, spread to many countries in less than a month. The full extent of its impact on global economy, governance structures and livelihood of persons is unprecedented and huge but not fully known (5). These international public health events have left human efforts to control them in more uncertainty and difficulties. Governance challenges for global health have long fascinated legal scholars and political scientists (9). With the recent COVID-19 outbreak, it is high time to re-examine the current landscape of international health cooperation, which is underpinned by various legal norms, processes and institutions (10). The outbreak of COVID-19 will again test the effectiveness of IHR specifically, and the moral and legal legitimacy of the WHO as a global health agency more broadly (10). It has placed the issue of international public health governance once again into the focus of the international community.

CHALLENGES OF COVID-19 TO THE INTERNATIONAL PUBLICE HEALTH

COVID-19 has been regarded as the "black swan" event of 2020, causing massive upheaval to businesses and impacting economic ecosystems on an unprecedented scale (11). While the WHO has been praised for its quickness in handling some of the more technical aspects of fighting a global pandemic, countries are taking their own approaches to the virus. In the case of China, early lockdown and forced quarantine measures seem to have been effective but such measures are not as easily implemented elsewhere (12). In South Korea, the focus has been on tracing the virus's spread through free, massive testing and then treating those who test positive. Social distancing has been encouraged through school closures, teleworking, and bans on large gatherings but forced quarantine has not been implemented (13). Italy and Spain, who delayed their containment strategies, have both favored less restrictive lockdown methods, though restrictions have increased as the situations in both countries have become more dire (14). In Germany, it is mainly local and regional governments that are responsible for health issues. The federal government's role is in most cases limited to coordinating the measures undertaken by the regional governments and to recommend a specific course of action for the whole country (15). Traditional global health leaders, such as the United States and the United Kingdom, proved unprepared for, and inept in responding to, the coronavirus (16). In the United Kingdom, a strategy of containment, delay, research, and mitigation have produced mixed results. Schools in the U.K. stayed open longer than countries on the continent and initial restrictive measures were aimed more at the most vulnerable like the elderly and those with comorbidities. While delaying actions may have allowed the U.K. to stave off some of the social and economic costs of the virus, it does not appear to have greatly lessened the spread of COVID-19 (17). The approach favored by several African countries has been stronger border protection *via* flight restrictions, visa denials, and 2-week quarantines for foreigners entering the country. While the numbers of infected persons remain lower on the African continent, it's unclear if this can be attributed to the tightening of borders (18).

At present, the main task of WHO and the state's governments is still to deal with the COVID-19, trying every means to control the epidemic and mitigate its harm. We do need to think locally, and act locally, but we also need to think and act globally. And ideas of global caring, global compassion, strong international institutions are really important (4). COVID-19 has challenged the sufficiency of even these significant global efforts (19), and the subsequent huge impacts impose new challenges to the global governance of international public health.

Limited Functions of International Organizations and Difficulties in Achieving Objectives

IHR2005 is the main legal basis for the international community to govern public health, and WHO is at the core of global public health governance. International normative documents lay down the basis and guarantee for international organizations to play their roles, and also provide the ways for international organizations to perform their functions. However, the ability of WHO to affect national health decisions that impinge widely on economic and social life is limited by a world order dominated by independent nations (20). Obligations stipulated in the IHR2005 are based on seeking a balance between the national and the international community's interest. Meanwhile, the world's central health agency, WHO, lacks the legal authority to ensure equitable, needs-based distribution of medical supplies and equipment and vaccines and therapies, during a pandemic, heightening the vulnerability of people in poorer countries (21). By contrast, regimes such as the World Trade Organization give primacy to intellectual property protection rather than affordable biotechnologies (22). The World Bank and International Monetary Fund ushered in an era of user fees for health services and structural adjustment that diminished national health budgets (22). And laissez-faire

capitalism gives carte blanche for transnational corporations to move to low-tax, low-regulation states, thus depleting domestic resources for health and failing to regulate corporate marketing, products, workplace safety, and environmental impacts that harm the public's health and safety (22).

The United Nations General Assembly (UNGA) and its Human Rights Council and United Nations Environment Programme (UNEP) have exerted far-reaching influence on the human rights and environmental protection issues involved in the response to public health events; the Office International Des Epizooties (OIE) and International Plant Protection Convention (IPPC) also enjoy the right to regulate the protection of plants and animals and organisms related to public health; the International Labor Organization (ILO) and International Maritime Organization (IMO) have adopted a large number of normative documents on labor and maritime navigation management issues arising from public health events. Therefore, they certainly do not provide us with warrant for a functionalist account of how governance arrangements for globalization would emerge, since the causal mechanism for selection seems even weaker at the global level than with respect to competition among states (23). The absence of a strong restraint mechanism will result in a lack of communication and coordination between the countries where PHEIC breaks out. Also, the role of international organizations in the joint response to PHEIC will be handicapped.

Poor Collaboration Between Governance Subjects and the Limited Performance

Globalization has intensified economic interdependence, global communication, and international migration, giving new urgency to addressing health issues globally and inaugurating a new era in global health governance to replace the former international health governance (24). The shifts in global health law have driven it from its twentieth-century home in the lawmaking authorities of the WHO Constitution and toward a wider, more diverse range of international actors, including other United Nations (UN) agencies, the WTO, international arbitral tribunals, the UN Security Council, and large enterprises in health-related sectors like food, medicine, and tobacco (19). Governance in the more global world of the twenty-first century has become distinctly multi-layered and trans-scalar (25). There are many subjects involved in international public health governance.

The COVID-19 outbreak exposes the collective vulnerability against the invisible enemy that penetrate national borders with ease (10). In the face of PHEIC, concerted efforts are needed from international organizations, countries, non-governmental social organizations, enterprises and individuals. In the fight against COVID-19, poor coordination between the international public health governance subjects remained a problem.

First, the problem of uneven global development and scarce medical materials is particularly obvious. People in lower income countries are most vulnerable to the ravages of climate change (26), and have health systems and a social and economic infrastructure less able to deal with novel and emerging infectious diseases (27). Poor governance, violence, and political instability is most often felt by people in lower income countries. By comparison, costly gene therapy and precision medicine are most available in wealthier countries (21). Current signs are worrying; critically needed medical supplies and equipment are going primarily to the United States and countries in Europe, which can pay more (28). Huge numbers of the world's people, overwhelmingly poor and marginalized, have not benefited from global health improvements (21). These immense global health disparities are echoed in gaping inequities within countries-sometimes narrowing, but often expanding (21). Global forces, however, make it exceedingly hard to achieve health with justice. There are vast differences in the resources available to governments around the world. Low- and middle-income countries often lack the resources needed to safeguard the public's health, especially if there are significant disease burdens and large or fast-growing populations. The possibility of COVID-19 unleashing a catastrophe on countries with weak health and social support systems is frightfully real.

Second, no country acting alone can ensure all of the conditions for health. Think about transnational forces such as greenhouse gas emissions, or global rules and norms in areas such as trade and investment (22), or transnational corporations that actively seek low-tax, low-regulation destinations-or the rapid spread of communicable diseases, like COVID-19. Geographically, the development imbalance can be observed at both the inter-state and intra-state levels. Whenever an epidemic breaks out, it is the affected country or region that responds first and needs the active response from other countries. The states that bear the disproportionate burden of disease have the least capacity to do anything about it, and the states that have the wherewithal are deeply resistant to expending the political capital and economic resources necessary to truly make a difference to improve health outside their borders (29). Despite IHR2005's demands of its member's improvement in their domestic health conditions, developing countries, economically and technologically backward, are still unable to improve their domestic public health systems. Large cities and rural areas within the same country are faced with different challenges when responding to a pandemic, due to, for example, the density of population and the state of the infrastructure (15). It is difficult for them to provide adequate medical materials within a short time to deal with PHEIC. Global health with justice-a world where all people, wherever they live and whoever they are, can equally benefit from health improvements-remains seemingly over the horizon (21).

Furthermore, most states are faced with differences in economic and medical development between different regions, which results in varying ability to respond to PHEIC in different parts of that state. For the states short of a strong central government in the middle of the regulation, it is easy for the different areas of that state to respond to a crisis in an in-coordinate manner. Trade also impacts an individual nation's willingness to regulate public health and safety standards (30). These incentives generate friction for mechanisms of cooperation, including international law, that emphasize information sharing, science-based decision-making,

and equitable access to health resources (16). Thus, the lack of cooperation or poor collaboration between the various governance subjects mentioned above seriously impaired the governance effect.

Overlapping Legal Basis of Governance and Blurred Core Function

Handling of PHEIC may, due to some reasons, involve the application of overlapping international laws to the same event, and blur the main legal basis offered by IHR2005 and other treaties for the international community governance of public health. These treaties do not provide for any legal consequences or responsibility for non-compliance with those obligations (31). Problems of "institutional overload" and inconsistent standard setting are already emerging in international health (32), involving public health issues in trade concerns faces many barriers, including institutional resistance and a lack of coordination and resources (30). To balance health, trade and movement of people, IHR2005 empowers its members to enact laws to implement health policies in accordance with their own circumstances, on condition that they stick to the purposes of IHR2005 in accordance with article 3.4 of IHR2005.

The outbreak of COVID-19 influenced the globalization. When the progress of globalization comes to a halt, governments are finding their commitment to free trade no longer the first priority (33). Therefore, by calibrating health and trade interests, the IHR resonate with international trade law under the WTO, which also recognizes the state's right to restrict trade for health purposes but limits this right to ensure that restrictions are necessary (34). Articles 7 and 8 of the TRIPS Agreement could represent both "context" and "purpose" in interpreting other TRIPS provisions pursuant to article 31.1 of the Vienna Convention on the Law of Treaties and thereby temper the strong rights granted to intellectual property holders by the TRIPS Agreement. However, they are fairly vague and aspirational provisions and therefore would be unlikely to resolve difficulties where the drafting is unambiguous and the "ordinary meaning" of given treaty terms are clear, as is arguably the case for compulsory licensing in connection with patented pharmaceuticals (35). Although it has become the consensus of international organizations and regions to strengthen international cooperation in addressing global health issues, unified coordination is still insufficient on how to regulate and guarantee international cooperation. With a plethora of international organizations sharing lawmaking authority for global health and with other health actors engaged in the international legislative process, international lawmaking shows potential for fragmented, uncoordinated and inefficient sprawl (9). The most important structural shortcoming of IHR is the lack of enforceable sanctions. For example, if a country fails to explain why it has adopted more restrictive traffic and trade measures than those recommended by WHO, no legal consequences follow. Based on the experiences of handling COVID-19 up to the time of writing this paper, it is apparent that there are many operational problems with the IHR2005. The role of the IHR2005 seems not to be critical in guiding States Parties for tackling the outbreak (36). The manner in which the pandemic exposed controversies and gaps in international law suggests that global health governance lack an effective system of law (16).

Lack of Solutions to Special Problems

The COVID-19 has many special problems which have been hitherto unknown because of its sudden and comprehensive nature. Concerns over potential erosions in democracy and respect for human rights caused by government responses to the COVID- 19 pandemic are situated among broader worries over worldwide democratic backsliding in recent years (37). As governments worldwide administer lockdowns, travel limitations, and other restrictions to respond to the COVID-19, some experts have warned of a "parallel epidemic" of government repression (38). Meanwhile, even when restrictions may be justified on the basis of public health, the manner of application and enforcement of these measures may raise human rights concerns in some cases (37). The increasing "securitization" of health law means it may become a primary instrument of abusive and arbitrary state power (39). For example, several states have deployed surreptitious cell phone technologies to track persons potentially infected with COVID-19 and their contacts (40). Take the Infodemic as an example. "Infodemic," like epidemics (41), involves the rapid spread of information of all kinds, including rumors, gossip and unreliable information. The world is in an era of network connectivity, information flooding and rapid dissemination. Once a public health emergency breaks out in a certain place, it will quickly become the focus of the world, and there will be a variety of online comments mixed with rational analysis and impetuous noise. Infodemic is an important part of outbreak response. It encompasses three main areas: (1) monitoring and identifying health threats, (2) outbreaks investigation, and (3) actions for mitigation and control (41). Behind this there are two reasons. First, to prevent the spread of the epidemic, the affected cities and countries may adopt lockdown policy, which increases the expectation of facts and security concerns. Second, people will feel worried about reality, which will be of little help. After the outbreak of COVID-19, the public media and Internet have been full of different voices, seriously denting the morale and enthusiasm of the people affected by the epidemic to fight against the epidemic. In view of this kind of phenomenon, some states have promulgated the bounded restrictions on the exercise some human rights, which arouses disputes. Experts worry that some restrictions fail to meet necessary principles to ensure respect for human rights (42). Others contend that during the pandemic, there has been increased pressure on civil liberties, such as threats to freedom of opinion, discussion, press freedom for journalists covering the news and scientists who had different opinions on the results of their research or studies (43). States of emergency are built on the somewhat artificial dichotomy of norm and exception, which endorses a bifurcated approach to balancing the interests of societal goals and individual rights (43). Therefore, the extent to which COVID- 19-related restrictions represent a departure from past governance patterns also may vary between states (37).

IMPROVE THE GLOBAL GOVERNANCE OF INTERNATIONAL PUBLIC HEALTH

As far as the competencies of the respective local governments worldwide are concerned, the situation differs from state to state. In a highly centralized state, local entities will be less able and therefore less inclined to invest in international cooperation when dealing with a health crisis, than local or regional governments in a more decentralized, federal structure (15). Much will depend on the allocation of competencies in the individual State as far as health issues are concerned (15). These different policy responses will often be transformed into different legal actions, so these patterns are helpful in understanding the role of law in connection with the globalization of public health (44). Health justice, then, is a fundamentally global concept and requires health equality within and across countries and regions (45). To achieve health justice and to ensure the smooth and efficient response to similar public health events in the future, the aforementioned challenges facing the international community in dealing with the epidemic can be addressed from the perspective of global governance in the following aspects.

Support the Role of International Organizations to Achieve the Objectives

The responsibility for implementing IHR2005 is shared by the states parties and WHO. As the largest international health organization, and one of the larger specialized agencies of the United Nations, the WHO has far-reaching responsibilities to address global public health based on the responsibilities assigned by its constitution and its affiliation with the United Nations (9). Article 2 of the Constitution lists 22 functions of the Organization which, given the size and scale of the COVID-19 pandemic, almost all seem relevant to the impact of the disease (5). The WHO has an unparalleled law-making power among the international organizations with lawmaking authority (10). With its amiable power and authority, the agency has an unequivocal power to influence international health policies, however, with the agency's visible reluctant to utilize its law-making power (46), commentators have observed that the WHO is more contented to act as a technical agency than embracing a leadership role in global health (46).

A framework convention on global health or a similar mechanism would not be easy to achieve, and it certainly would not provide an ideal solution, but at least a framework convention would go toward the heart of the problem-that is, it would address state's obligations to act outside their borders and thus establish the levels of commitment and the kinds of interventions necessary to make a meaningful difference for the world's population (29). In day-to-day public health governance, states parties should work actively with WHO, mobilize financial resources, and facilitate the implementation of their IHR2005 obligations; they must improve their national surveillance and response infrastructure so as to enable timely warning of public health risks and emergencies. In the event of a public health risk or emergency, the states parties shall promptly notify WHO of the relevant risks and circumstances; WHO should assess the situation in the country where the risk or event occurs, and establish a special event information website. During the duration of the risk or event, the states parties shall faithfully report to WHO on a daily basis for WHO to publish the data on the information website; WHO shall make relevant information available to all focal points of states parties and the public, along with progress, guidance and warnings. In the case of a particular outbreak, WHO should assign commissioners to the outbreak site for investigation, so as to make a better response. All the above functions shall be strictly observed and carried out by WHO and the states parties. In particular, the states parties shall provide all facilities and support to WHO for the organization to better perform its duties. Also, WHO is in the process of establishing specific indicators for core competency readiness, which it hopes will help to better gauge member state's preparedness to respond to a public health emergency (47).

At the local level, the handling of COVID-19 and control of its spread are supposed to be the duties of the governments in the respective jurisdictions. At the international level, WHO is supposed to work closely with governments and to lead the world to fight against the outbreak based on IHR2005 (36). No matter whether some of the criticism of the WHO's initial reaction to the crisis is justified or not, surely it is to the world's advantage to already have such a forum in order to share experiences and resources (15). In an interconnected world, driven by an increased rate of economic globalization, global governance of health is a contentious field, often fought with ideological disagreements (10). It is with this knowledge that at the special summit on COVID-9 the parties committed themselves to taking all necessary actions within their respective mandates with relevant international organizations, including WHO, expressing full support and commitment to further enhance WHO's role in coordinating international anti-epidemic actions (48).

Enhance Coordination Among International Governance Subjects to Form Synergy

Global governance refers to formal and informal sets of arrangements in global politics insofar as it implies that states alone cannot manage global affairs, but have to acknowledge the contributions of international governmental organizations, non-governmental organizations, and multinational corporations (49). In addition, given the increasingly active role of the public and transnational enterprises in the governance of international affairs, transnational corporations and industry elites should also be included in the main subjects of global governance. Among these subjects, countries are the fundamental driving force to promote global governance of public health, and the role of WHO in the global governance of public health is to be a leader, the coordinator and the platform provider. Theoretically, the diversity of governance subjects is based on the principle of subordination. The influential role that non-state actors play within international society cannot be denied (49). It is self-evident that stopping the spread of and dealing with a pandemic that threatens the whole world necessitates international cooperation in order to be effective (15). International cooperation is critical to combatting

pathogenic threats (16), due to the differences in economic development, medical supplies and scientific and technological personnel reserves between different countries and between different parts of a country, it requires effective collaboration between different governance subjects.

Set up virtual medical platform to remedy defects caused by gaps in development. In the event of PHEIC, some countries may be reluctant to export scarce raw materials and medical resources. Therefore, a strong international stockpile helps ensure the supply of medical resources and necessities, regardless of whether they are produced or stored in certain countries. There is a condition for global health with justice is an international order and transnational action that systematically advances the conditions for good health and for accountable governance, particularly for people in countries on the short end of global health disparities (21). It is advisable to set up a virtual warehouse under the framework of WHO. This virtual warehouse is not a real warehouse, so that there is no need for each member country to actually deposit its claimed materials. The virtual warehouse is mainly used to store scarce raw materials and medical resources. Health financing is a critical, but often neglected, component of global governance of health (10). The funding sources of the warehouse can be divided into the following categories. a. reserved assessed amount by states parties. Member states claim a corresponding amount of medical products in proportion to their contributions on a yearly basis; b. social donation. The virtual warehouse is open to the whole society, so that all organizations, enterprises and individuals can provide targeted donations; c. additional donation. Countries with national supply or domestic manufacturing capacity contribute additional medical supplies to the virtual warehouse in addition to their assessed amounts. WHO acts as the manager of the virtual warehouse. In the event of a major outbreak, the affected country or region may apply for allocation of resources in accordance with the procedures prescribed by WHO. WHO may, after reviewing and approving the application, according to the principle of proportion and cost, direct countries which are not affected by the outbreak to provide appropriate medical materials to affected are as so as to overcome the plight of insufficient medical facilities caused by regional development gaps.

Promote cooperation between countries. As a consequence of globalization, governments must turn increasingly to international cooperation to attain national public health objectives and achieve some control over the trans-boundary forces that affect their populations (32). As a result, countries in today's world have long formed an interdependent relationship. Interdependence leads to shared benefits, which in turn encourage mutual cooperation. Public health features universality, actuality and practicality in its application, because it involves the fundamental and pervasive aspects of people's lives, so it is easier for public health to be generally recognized and applied. Therefore, cooperation is conducive to the well-being of the people, and will achieve the cooperative positive effect. With the rapid outbreak of the novel coronavirus across the global, effective containment of the outbreak requires global concerted efforts (10). Leadership from heads of state and government could help propel these ideas onto national and global agendas, providing critical support (21). Having paid a disastrously heavy price, the international community has eventually woken up and strengthened joint efforts in combating the virus (50). The G20 Extraordinary Leader's Summit held on March 26 in response to the COVID-19 pandemic marked the formation of an international consensus, where leaders expressed their commitment to "task our top relevant officials to coordinate closely in support of the global efforts to counter the pandemic's impacts." Countries should cooperate actively in the face of a public health event. First, the affected countries or regions should take measures as soon as possible to prevent the epidemic from spreading to other countries. Second, other countries should help the affected countries as much as possible. State and local health departments are key to protecting the nation from epidemics (51). In today's globalized world, to help other countries to break away from the impact of public health events is essentially to help oneself. To take China as an example, in its fighting against the sudden outbreak of COVID-19, China has received support and assistance from foreign governments, enterprises, non-governmental organizations as well as friendly people worldwide. As its domestic situation was gradually stabilizing, China began providing support and assistance in various forms to the WHO and related UN agencies, neighboring countries, developing nations, and even the United States and European countries, which has been widely praised by the international community (52).

Build an effective mechanism for wide participation of the whole society. While the WHO recognizes its responsibility as stated in the Constitution for nomenclature of diseases, it has also been mindful of its functions to co-ordinate with other UN Specialized Agencies and scientific and technical groups (5). The vast array of international health actors actively involved in global health cooperation, combined with people's widespread criticism of the United Nations and its specialized agencies, have led some commentators to suggest a diminishing role for intergovernmental organizations in global health governance. Achieving global health justice requires authentic cooperation because the production of health equity at the global and domestic levels involves interdependent parties. This task requires individuals and groups to embrace and successfully fulfill respective roles and responsibilities based on functions and needs and voluntary commitments (53). Some have emphasized a "power shift" from intergovernmental organizations to private-sector actors and the innovative health coalitions described above (54). Because public-private partnerships have proliferated since 2,000, the contractual relationships between firms, governments, and large health-oriented foundations will serve as a significant source of global health law (19). The dispersal of governance in contemporary history has occurred not only across different layers and scales of social relations from the local to the global, but also with the emergence of various regulatory mechanisms in private quarters alongside those in the public sector (25). People are demanding decent health services. They want caring, compassionate, and highly qualified professionals. They demand affordable access to essential medicines, vaccines, and medical devices (21). To effectively respond to major disease outbreak, in addition to the government and scientific research institutions,

large pharmaceutical enterprises and research and development centers also play an active role with their advanced research resources, and strong capability of R&D on immune and anti-epidemic drug. What's more, in combating the epidemic, donations from all walks of life have greatly alleviated the plight of medical resource shortage and material shortage in the most-affected areas. Given today's high-tech development, technology companies that dominating artificial intelligence and medical drug development are an indispensable in the fight against infectious diseases. The large number of volunteers are also a solid force for countries to deal with the outbreak. Therefore, WHO and countries should actively support and encourage enterprises and individuals to make joint efforts.

Promote Compliance With IHR2005 to Avoid Conflict of Law Application

International law is the foundation of the international order, without which there would be no order in the international community. The 2003 SARS outbreak killed 916 people in 32 countries and regions, according to figures released by WHO on August 15, 2003 (55). The challenge for post-Westphalian public health is to create the conditions necessary for the governance innovations practiced in the SARS outbreak to be refined, improved, expanded, and sustained to meet the ongoing threats pathogenic microbes present (56). WHO adopted a series of internal working regulations and the IHR2005, which requires all countries to develop and maintain core health system capacities (4). Designed to enhance international health cooperation and provide an international legal framework, the IHR2005 aims to prevent, protect against, control and provide a public health response to the international spread of disease in ways that are commensurate with and restricted to public health risks, and which avoid unnecessary interference with international traffic and trade. Global health law encompasses the legal norms, processes, and institutions needed to create the conditions for people throughout the world to attain the highest possible level of physical and mental health (57). The need for international law in global public health is greater, however, than the attitudes of any particular WHO administration. WHO needs to take international law more seriously because the structure of international politics places international law in a central position in state's attempts to deal with global problems (44). Although the IHR2005 is the main international agreement on infectious diseases, the regulations do not govern every challenge that disease events create (16). The role of international law in the global governance is to guarantee the international public interest.

The 2005 World Summit Outcome adopted by the UNGA solemnly declares. We acknowledge that good governance and the rule of law at the national and international levels are essential for sustained economic growth, sustainable development and the eradication of poverty and hunger. Therefore, it is significant to recognize the need for universal adherence to and implementation of the rule of law at both the national and international levels. Against the background of global governance, a feasible means of addressing problems of global concern and avoiding power struggles among nations is to set up an international code of conduct through international collaboration and, on this basis, establish a predicable international system and develop a just and effective model of global governance (58). IHR2005 is both the norms of international law to deal with international public health problems formed on this basis, and also the basis of the international order followed by various subjects of international public health governance. Obviously, public health is critical to almost all major global governance issues, including national and international security, trade and economic development, environmental protection and human rights. IHR2005 has changed the traditional ways international community handles public health issues, and provided an important platform for extensive international communication.

The frameworks and platforms created by IHR2005 not only support international cooperation for improved health, but also underpin the strengthening of health systems within members, so as to generate stronger horizontal and vertical health governance among and within members. This change has the potential to contribute significantly to the overall task of global governance, improvement of the health of its members and all mankind. In the field of trade in goods, some have argued that in response to such concerns countries should pursue legal actions through the WTO and Article XX (b) of the General Agreement on Tariffs and Trade in order to ban potentially dangerous imports until the safety of such goods can be effectively established (59). The interdependence between international and national law emphasized by global health jurisprudence tends to be more robust when law supports governance actions that integrate power and ideas in a coherent and sustainable manner (7). Documents adopted by other international organizations, although with institutions related to public health, contain no provision for PHEIC. Therefore, in the event of PHEIC, IHR2005 should be given more attention than other international normative documents, even if there is inconsistency in the application of specific international laws.

Uphold the Vision of a Community With a Shared Future for Mankind to Jointly Respond to the Special Problems

PHEIC is the common "enemy" of all humankind, which calls for countries to stop distinguishing between one another, and uphold the vision of a community with a shared future for mankind to jointly respond to the emergency. No country can fight an international epidemic by itself and yet, with the rise of populism and nationalism, the idea of "my country first," where there is such a focus on economics, trade and self-interest, and so little on common global security (4). Building a community with a shared future for mankind was put forward by China as a global governance plan for the world (60). Today, "Jointly promote the building of a community with a shared future for mankind" has appeared in some important bilateral political declarations. For example, *The Joint Statement of the People's Republic of China and the Russian Federation* on June 8, 2018, *The Qingdao declaration of the Council of heads of state of the*

SCO member states on June 10, 2018, and *The Beijing Declaration on building a closer community of common destiny for China and Africa* on September 3, 2018. Moreover, the concept of "building a community with a shared future for mankind" has been written into UN resolutions and is being included into the fundamental principle of international law.

Regardless of whether a public emergency has been declared, the International Covenant on Civil and Political Rights (ICCPR) also allows for bounded restrictions on freedoms of movement, assembly, expression, and association when necessary to protect public health. Some human rights treaties allow for bounded restrictions on the exercise of some human rights to meet public health crises. Most notably, ICCPR provides for certain derogations and restrictions (37). Emergency powers generally allow government powers to promptly respond to public emergencies in order to restore order and national security by suspending the ordinary legal system (61). According to the International Center for Not-for-Profit Law, 46 countries have instituted laws, policies, or practices related to COVID-19 that affect free expression in some way (62). "State of emergency" is therefore a label that may provide instant legitimacy to the greater limitation of human rights by government (63). Many governments have instituted or carried out control on the media and free expression under the justification of preventing the spread of misinformation or disinformation about the virus, with both new and existing laws and policies providing government officials the authority to prohibit the spread of virus-related information deemed they deem to be false or harmful (37).

As to Infodemic mentioned before, the prevention and control of infectious diseases inevitably involve the reduction and restriction of rights, but sanitary measures that restrict individual rights must follow the principles of necessity and fairness. Public health authorities around the world have been legitimately concerned about disinformation during the COVID-19 pandemic. Unreliable information, particularly when disseminated by individuals with significant platforms, can cause grave harm, whether maliciously intended or not. WHO has stated that "successful management of infodemics will be based on (1) monitoring and identifying them, (2) analysis of them, and (3) control and mitigation measures" (41). In the twentieth century, the exercise of public health powers that infringe individual rights faded in developed countries as public health and healthcare systems improved (64).

Paragraph 1 of article 3 and article 32 under IHR2005 demonstrates the importance of human rights protection in international health governance. In order to explain the relation between good governance and human rights, Koch points out that the former is something to which the individual is entitled, whereas the latter is something that the authorities are under an obligation to uphold (49). Therefore, the IHR2005 not only stipulates the goals of international public health governance, but also incorporates the principle of human rights into its implementation system, thus constructing the public health system that integrates security, economy, people's livelihood, development and human dignity with the attributes of public goods, rather than the previous IHR2005 only limited to removing restrictions on trade and travel. Public opinions are the sum of the beliefs, attitudes, and emotions of the public in response to the phenomena and problems in the society, mixed with rational and irrational factors. However, how public opinions are developed determines whether their effects on social development and the course of events are positive or negative. In the modern society featuring highly developed Internet access, people's ideas and values are more diversified, so are their ways of receiving information and channels of spreading information. Also, compared with the traditional model, the development of public opinions is more rapid, and the truth and rumor also exert a more obvious double-edged sword effect.

Against this background, the importance of public opinions is self-evident. Therefore, WHO, as the provider of information and guidance for the global response to PHEIC, should, while ensuring timely release of accurate information, clarify the false information spread in the society, so that all people can feel optimistic about the situation through the spread of true information. Information management may be seen through the lens of government obligations and company responsibilities, particularly companies involved in Internet searching or social media. On Feb. 14, WHO officials met with representatives from more than a dozen U.S. technology companies, including Facebook, Google, Amazon and the major topic of discussion was how the companies are working to tamp down the spread of misinformation (65). In addition, all news media and other media should work hard to contain the spread of wrong information about the epidemic so as to avoid public panic which may affect the efforts for the prevention and control of the epidemic.

CONCLUSION

International public health has long ago been a common problem troubling the international community, which call for the joint response from all mankind. COVID-19 and its subsequent huge impact impose new challenges to the global governance of international public health. Facing the severe public health crisis the world has suffered, and the prevention mechanism established by the IHR2005 has not achieved the expected results. Particularly the recommendations issued by the WHO have not been universally adopted by member states, which expose some urgent problems in the international public health governance system. COVID-19 and other PHEIC are the common "enemy" of all humankind, which requires states to have a strong sense of unity, and uphold the vision of a community with a shared future for mankind to jointly respond to the epidemic.

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

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Vaccine Confidence and Hesitancy at the Start of COVID-19 Vaccine Deployment in the UK: An Embedded Mixed-Methods Study

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Background: Approval for the use of COVID-19 vaccines has been granted in a number of countries but there are concerns that vaccine uptake may be low amongst certain groups.

Methods: This study used a mixed methods approach based on online survey and an embedded quantitative/qualitative design to explore perceptions and attitudes that were associated with intention to either accept or refuse offers of vaccination in different demographic groups during the early stages of the UK's mass COVID-19 vaccination programme (December 2020). Analysis used multivariate logistic regression, structural text modeling and anthropological assessments.

Results: Of 4,535 respondents, 85% (n = 3,859) were willing to have a COVID-19 vaccine. The rapidity of vaccine development and uncertainties about safety were common reasons for COVID-19 vaccine hesitancy. There was no evidence for the widespread influence of mis-information, although broader vaccine hesitancy was associated with intentions to refuse COVID-19 vaccines (OR 20.60, 95% CI 14.20–30.30, $p < 0.001$). Low levels of trust in the decision-making (OR 1.63, 95% CI 1.08, 2.48, $p = 0.021$) and truthfulness (OR 8.76, 95% CI 4.15–19.90, $p < 0.001$) of the UK government were independently associated with higher odds of refusing COVID-19 vaccines. Compared to political centrists, conservatives and liberals were, respectively, more (OR 2.05, 95%CI 1.51–2.80, $p < 0.001$) and less (OR 0.30, 95% CI 0.22–0.41, $p < 0.001$) likely to refuse offered vaccines. Those who were willing to be vaccinated cited both personal and public protection as reasons, with some alluding to having a sense of collective responsibility.

Conclusion: Dominant narratives of COVID-19 vaccine hesitancy are misconceived as primarily being driven by misinformation. Key indicators of UK vaccine acceptance

include prior behaviors, transparency of the scientific process of vaccine development, mistrust in science and leadership and individual political views. Vaccine programmes should leverage the sense of altruism, citizenship and collective responsibility that motivated many participants to get vaccinated.

Keywords: COVID-19, vaccines, mixed-methods, anthropology, trust, misinformation

INTRODUCTION

In December 2020, the United Kingdom became the first country to approve the use of a vaccine directed against SARS-Cov-2 after successful trials of the Pfizer/BioNTech BNT162b2 mRNA vaccine (1). Regulatory approval of the Oxford University/AstraZeneca ChAdOx1 (2) and Moderna mRNA-1273 (3) products brought two additional vaccines to the UK market by early January 2021. Immediately after the licensing of BNT162b2, the UK government commenced an ambitious national vaccination campaign that aimed to maximize the short-term impacts by (1) leveraging the probability that there would be high levels of efficacy from a single dose of (any available) COVID-19 vaccine and (2) by delivering available vaccine to older and clinically vulnerable individuals first (4). The UK's gamble on the effectiveness of a single dose was vindicated by subsequent evidence that a single dose of BNT162b2 was highly protective against emergency hospitalization and mortality, whilst a single dose of ChAdOx1 similarly protected from severe disease (5). Early findings from passive surveillance of household transmission in England (6) also showed that vaccination was associated with a reduced secondary attack rate, suggesting that vaccinated people who contracted SARS-CoV-2 infections were less able to transmit infection than unvaccinated people (7). The UK's vaccination strategy and programme has been hailed a success, with three-quarters of all UK adults having received at least one dose of a SARS-CoV-2 vaccine and 50% having received two doses by 2021-03-17 (8). This figure is somewhat higher than the estimates of a June 2020 survey of around 13,000 people in 19 countries, which reported that on average 71% of respondents were either likely or very likely to accept a SARS-CoV-2 vaccine. The very high uptake of SARS-CoV-2 vaccines in the UK appears to indicate a substantial increase in SARS-CoV-2 vaccine confidence and also seems to fly in the face of both (1) that these vaccines remain mostly uncharacterised for long-term safety and (2) that there has been a recent national and global trend of vaccine hesitancy for a range of vaccines (9) which has emerged as one of the most significant and complex public health challenges of the twenty-first century.

The WHO SAGE Working Group on Vaccine Hesitancy previously developed the "3 Cs" model of vaccine hesitancy (10) which describes three key factors [Confidence, Complacency, Convenience] that contribute to vaccine hesitancy. The success of the UK's SARS-CoV-2 vaccination strategy can potentially be explained as having made the process of vaccination highly *convenient* by making a sufficient number of vaccine doses available through the National Health Service (NHS), at local health centers and at zero cost to the public. The level of *complacency* is also likely to be very low because of the highly visible personal, social, cultural, economic and global impacts of the pandemic. The drivers and extent of UK *confidence* in SARS-CoV-2 vaccines are however more debatable (11) and in this work we aim to understand how individuals living in the UK made decisions about their intentions to either accept or refuse vaccination at the very beginning of the UK national vaccination programme that commenced in December 2020. In order to achieve this goal we carried out an online survey of ∼4,500 adults living in the UK and applied an embedded mixed-methods approach to analysis and interpretation.

MATERIALS AND METHODS

Ethics Approval and Consent to Participate

This study was approved by the research ethics committees of the London School of Hygiene & Tropical Medicine (ref: 17860) and World Health Organization (ref: CERC.0039B). The data were fully anonymous and the study team were unable to identify any respondents. The respondents provided informed consent at the start of the survey by means of ticking a box on the web-form. All questions in the survey were optional, meaning that participants could skip questions if they did not want to divulge specific data.

Survey Design

We designed and deployed an embedded mixed-methods online survey as previously described (12). Briefly, the survey included both quantitative and qualitative (open-ended text) questions that were relevant to the UK COVID-19 outbreak, COVID-19 vaccines and their relationship to participants' health, health behaviors and attitudes. All data were collected anonymously and securely using ODK (13). The survey was advertised using Facebook's premium "Boost Post" feature (14) and ran from 2020-12-08 to 2020-12-16. All questions in the survey were voluntary, meaning that participants could skip questions that they did not wish to answer. Adverts were targeted to the eligible population of people aged 18 and over and living in the UK. All participants were asked to provide informed consent and to confirm their eligibility.

The survey included questions on the topics of (1) Demographics, (2) Compliance with testing and isolation following COVID-19 symptoms, (3) Use of the NHS COVID-19 contact tracing app, (4) Trust in the government and their decision making, (5) Health condition and exercise, (6) Domestic and gender-based violence and (7) Attitudes toward vaccination.

Study respondents were asked "When COVID-19 vaccines become available, will you be happy to get vaccinated?" [Yes | No], "Why would/wouldn't you get vaccinated?" [Free text] and "Which of these best describes your general feelings about vaccines?" [I believe that vaccines are an effective way to control

infectious diseases | I have concerns about the usefulness of some or all vaccines, but have not turned down the offer of vaccination for me or a member of my household | I have concerns about the usefulness of some or all vaccines and have previously turned down one or more offers of vaccination for me or a member of my household]. To gauge previous vaccine seeking behaviors, we asked participants "Do you get a seasonal flu vaccine?" [Always/Usually | Sometimes | Never]. Participants indicated if they were disabled as described in section 6 of the UK Equality Act 2010 [Yes | No] and provided a self-assessment of their general health over the last 4 weeks [Very bad | Bad | Fair | Good | Very good].

Respondents were further asked "Do you think that the UK government (Westminster) is making good decisions about how to control COVID-19?" [Yes/No], "Do you think that the UK government tells you the whole truth about coronavirus and COVID-19" [Always | Mostly | Sometimes | Almost never | Never | I don't know] and "Do you feel that your household has experienced financial hardship as a result of COVID-19" [Yes | No].

Demographic variables included in the analysis were age group [18–29 years, 30–49 years, 50–69 years, and 70+], gender [Female | Male | Another gender], highest educational attainment [GCSEs/O-levels | A levels/Highers | Degree or higher degree], ethnicity [using UK Government 2011 census groups (15)] employment [Full time | Part time | Home-maker | Retired | Student | Unemployed], annual household income [Less than £15,000 | £15,000–£24,999 | £25,000–£39,999 | £40,000–£59,999 | £60,000–£99,999 | £100,000+], political views [Conservative/Right" | Floating/Centre | Liberal/Left] and UK postcode area. Participants also provided information on whether they had prior doctor-diagnoses of several medical conditions including asthma, cancer, type 1 and 2 diabetes, heart disease, hypertension, lung disease, obesity, stroke, depression, and anxiety. To assess recent signs of acute depression, participants were asked "How often did you feel down, depressed, or hopeless in the past 4 weeks [Not at all | less than half the time | More than half the time | Every day].

Analysis

Analysis was performed using R version 4.0.3. Missing data were imputed using the R package "mice" (16). For downstream analysis, 15 imputed data sets were pooled using the R package "sjmisc" to find the modal value for each missing data point. The number of survey responses from ethnic minority groups was low and for statistical purposes we categorized ethnicity into two classes [White | Ethnic minority]. Acute depression was classified as none [Not at all], mild [less than half the time] and moderate-severe [More than half the time | Every day]. Univariate binomial logistic regression was used to determine whether there was evidence for an association between each variable and the outcome of vaccine acceptance. Any variable that was significantly associated (after false discovery correction for multiple testing) with vaccine acceptance decisions in univariate analysis ($Q < 0.05$) was then included in a multivariate binomial logistic regression analysis.

Topic Modeling

Structural topic modeling (STM) of open-ended text was used to identify key topics associated with acceptance and non-acceptance of a COVID-19 vaccine using the R package "stm" (17). Free text responses to the question "Why would/wouldn't you accept a COVID-19 vaccine?" were processed into separate text corpuses [accept/refuse] and analyzed individually. Common stop-words (and, is, don't, can't etc.) and semantically neutral words such as "COVID" and "Vaccine" were removed. The number of topics that were included in each analysis was determined from visualization of charts comparing several key indicators provided by the STM process, including semantic coherence (e.g., the clarity of topics), held-out likelihood (e.g., likelihood of retaining documents in the analysis) and minimal residuals of the model fit. When identifying the optimal number of topics to include in the analysis, we sought to maximize the held-out likelihood (number of documents retained) whilst minimizing the residuals. STM assigned a set of scores (theta scores) to each free-text response or "quote" in the corpus and these scores could be used to assign each quote to one or more of the topics. We extracted the highest scoring quotes (theta > 0.3) for each topic and used a lazy-consensus approach to defining the topic names that we felt best described the content of the group of quotes that had been assigned to each topic. A list of the most frequent words used within the quotes assigned to each topic was produced, along with a correlation matrix showing the relationships between topics based on the correlation of the maximum *a posteriori* estimates for the topic proportions. STM topics with correlation >0.25 were grouped together as subtopics of a single topic. Topics which were assigned fewer than five quotes with theta >0.3 were not included in the analysis.

The STM process was performed once for the corpus of quotes provided by those who said that they would accept a COVID-19 vaccine, then separately for the corpus provided by those who intended to refuse a vaccine.

Qualitative Analysis

In each of the two STM analyses, we extracted those quotes that had theta scores above 0.3. This approach was taken on the assumptions that (1) quotes with a high theta score for a specific topic were likely to be highly representative of the topic and (2) that these quotes were unlikely to have content crossover with other topics because the high theta score was proportional to high exclusivity (noting that the individual topic theta scores for each quote always add to 1.0). Detailed thematic qualitative analysis then allowed us to perform a thorough and nuanced exploration of the topic content and meanings.

RESULTS

The advert and survey were active between 2020-12-08 and 2020-12-18. The total "reach" of the Facebook advert (i.e., the total number of individuals to whom the advert was displayed at least once) included 120,826 people living in England ($n = 99{,}834$), Scotland ($n = 10{,}368$), Wales ($n = 8{,}384$), and Northern Ireland ($n = 2{,}240$). The advert reached 69,115 females, 48,534 males and 2,176 people who did not declare their gender on Facebook. The

link to the survey webpage was clicked 7,472 times (an overall click-through rate of 0.0618 and cost per click £0.16). In total, 4,535 respondents completed the survey (overall conversion rate from advert to survey completion 0.038, cost per survey response £0.22). There was substantial heterogeneity in the click-through and conversion rates among different age and gender groups.

Demographically, the cohort had notably high levels of representation from females (65%), people aged 50–69 (61%) and people who were educated to degree level or higher (55%). The survey had very low representation of ethnic minority groups (3%) which is in keeping with our findings in a previous (similarly designed) survey (12, 18). Other demographic factors including postcode areas, income and employment were more evenly represented in the cohort (**Table 1**). The respondents were located in England ($n = 3{,}910$, 86.2%), Scotland ($n = 316$, 7.0%), Wales ($n = 263$, 5.8%), and Northern Ireland ($n = 46$, 1.0%).

Overall, 85% (3859/4535) of participants indicated that they would accept a SARS-CoV-2 vaccine if offered one. **Table 1** provides a summary of the survey's demographic data and the results of both the univariate and multivariate logistic regression tests. Showing only those variables where there were significant differences between the groups in multivariate analysis, **Figure 1** illustrates the odds ratios and associated confidence intervals of intending to reject an offer of a COVID-19 vaccine in different groups who took part in the study.

The STM analysis identified 16 topics (REF01–REF16) that together described the key reasons given for refusing a COVID-19 vaccine (**Table 2**). Topic REF16 had too few quotes and was dropped from the analysis. A further 16 topics (ACC01-ACC16) were identified for the group who intended to accept COVID-19 vaccination (**Table 3**). Seven sub-topics (ACC02ii, ACC04iii, ACC04v, ACC05i, ACC05ii, ACC05iii, and ACC05v) had fewer than five quotes with theta >0.3 and were dropped from the analysis.

Government Decisions

We found that just 21.7% ($n = 982$) of study participants thought that the UK government was making good decisions about the control of COVID-19. After adjusting for all covariates in a multivariate regression analysis (**Figure 1** and **Table 1**), the odds ratios of COVID-19 vaccine refusal were found to be higher amongst those who did not believe that the UK government was making good decisions about the COVID-19 response (OR 1.63, 95% CI 1.08–2.48, $p = 0.021$).

In topic ACC06, respondents expressed how their intention to be vaccinated was informed by their strong trust in science, the NHS, scientists and scientific method. These respondents were not equally positive about the role of the UK government and some made it clear that although they had doubts about the government's role, this did not deter them from accepting vaccines.

> *"Although I have little faith in the government, I do have faith in the UK's medical approval authorities and processes"*

> *"I trust science, and our NHS, despite the government's manipulation of the situation."*

Among the quotes from potential vaccine refusers, criticisms of the government were generally focussed on questions surrounding their motivations, truthfulness and political or social agenda.

Government Trust

Nearly one third of respondents (29.7%, $n = 1{,}344$) believed that the UK government never, or almost never, told the whole truth about coronavirus and COVID-19. The odds ratios of COVID-19 vaccine refusal were higher amongst those who thought that the UK government "never" (OR 8.76, 95% CI 4.15–19.9, $p < 0.001$) or "almost never" (OR 4.79, 95% CI 2.31–10.73, $p < 0.001$) told the whole truth about COVID-19.

In topic REF02, participants expressed their skepticism about the UK government's role in the very rapid process of COVID-19 vaccine development. Many of the respondents whose quotes made up topics REF02 and REF03 felt that it was hard to believe that a valid and legitimate process could be completed in such a short time.

> *"Not enough testing (8–12 months compared to 8–12 years for normal vaccine development), too much secrecy regarding content and method of production, problems arising even in early cases."*

> *"I religiously get my flu jab each year, and have had numerous other vaccinations throughout my life—the only negative experience was when I was in the NHS in the 1980s when Hep C jabs were being promoted that had been formulated from Us [USA] blood products, but this has not stopped me having all the other proven vaccines above....However re COVID-19:- I'm not convinced by the lack of studies of long term effects; need to know more about differences between the vaccines; interested to know how the MHRA had all the info re Pfizer, when the final results were released a week after they had said it was okay; the optics of share sales (moderna)/efficacy results changing within hours of a share price crash (astra zeneca) are not altogether encouraging either."*

These concerns appeared to reflect suspicions that were implicitly leveled at both the government (REF02) and pharmaceutical companies (REF10).

> *"Because the medical profession tell us that it takes between five and ten years to perfect a good vaccine, we are being told that Pfizer, has done this in six months. Garbage."*

> *"Please! If a cure couldn't be found for Coronovirus or the other cold viruses since research started in 1947, then ergo, these 'vaccines' have obviously already been manufactured well before the 'pandemic'. My question is...Why?"*

Others were suspicious not only of the timeline of development, but also of the potential for personal financial gain for ministers and the alleged provision by the government of legal indemnities to pharmaceutical companies.

> *"No confidence or trust whatsoever in the testing regimes for the vaccines. If they are so good why has [the] government given immunity from prosecution in the event of adverse reactions to big pharma companies?"*

TABLE 1 | Sample characteristics, univariate, and multivariate analyses.

Characteristic	Total (N = 4,535) n %[†]	Accept vaccine (N = 3,859) n %[††]	Reject vaccine (N = 676) n%[††]	Univariate analysis				Multivariate analysis		
				OR[a]	95% CI[a]	p-value	q-value[b]	OR[a]	95% CI[a]	p-value
Gender						0.001	0.002			
Female	2,983 (65.8%)	2,577 (86.4%)	406 (13.6%)	—	—			—	—	
Male	1,527 (33.7%)	1,264 (82.8%)	263 (17.2%)	1.32	1.11, 1.56			1.23	0.94, 1.61	0.13
Other genders	25 (0.6%)	18 (72.0%)	7 (28.0%)	2.47	0.95, 5.70			1.05	0.25, 4.03	>0.9
Age						<0.001	<0.001			
18–34	149 (3.3%)	122 (81.9%)	27 (18.1%)	—	—			—	—	
35–54	1,375 (30.3%)	1,096 (79.7%)	279 (20.3%)	1.15	0.75, 1.81			1.14	0.57, 2.34	0.7
55–69	2,222 (49.0%)	1,914 (86.1%)	308 (13.9%)	0.73	0.48, 1.14			0.96	0.47, 2.03	>0.9
70+	789 (17.4%)	727 (92.1%)	62 (7.9%)	0.39	0.24, 0.64			0.55	0.24, 1.30	0.2
Education						<0.001	<0.001			
School	878 (19.4%)	709 (80.8%)	169 (19.2%)	—	—			—	—	
Further	1,173 (25.9%)	980 (83.5%)	193 (16.5%)	0.83	0.66, 1.04			1.06	0.74, 1.51	0.7
Higher	2,484 (54.8%)	2,170 (87.4%)	314 (12.6%)	0.61	0.49, 0.75			1.29	0.92, 1.81	0.14
Employment						<0.001	<0.001			
Full time	1,275 (28.1%)	1,036 (81.3%)	239 (18.7%)	—	—			—	—	
Part time	774 (17.1%)	651 (84.1%)	123 (15.9%)	0.82	0.64, 1.04			1	0.70, 1.43	>0.9
Retired	1,987 (43.8%)	1,789 (90.0%)	198 (10.0%)	0.48	0.39, 0.59			0.63	0.43, 0.92	0.016
Student	65 (1.4%)	53 (81.5%)	12 (18.5%)	0.98	0.49, 1.80			1.8	0.66, 4.53	0.2
Homemaker	231 (5.1%)	171 (74.0%)	60 (26.0%)	1.52	1.09, 2.10			1.29	0.79, 2.09	0.3
Unemployed	203 (4.5%)	159 (78.3%)	44 (21.7%)	1.2	0.83, 1.71			0.68	0.38, 1.18	0.2
Disabled						0.003	0.005			
No	4,044 (89.2%)	3,464 (85.7%)	580 (14.3%)	—	—			—	—	
Yes	491 (10.8%)	395 (80.4%)	96 (19.6%)	1.45	1.14, 1.84			1.44	0.96, 2.14	0.071
Ethnicity						0.002	0.003			
White	4,388 (96.8%)	3,748 (85.4%)	640 (14.6%)	—	—			—	—	
Ethnic minority	147 (3.2%)	111 (75.5%)	36 (24.5%)	1.9	1.28, 2.76			1.23	0.65, 2.24	0.5
COVID-19 symptoms						<0.001	<0.001			
No	3,525 (77.7%)	3,037 (86.2%)	488 (13.8%)	—	—			—	—	
Yes	1,010 (22.3%)	822 (81.4%)	188 (18.6%)	1.42	1.18, 1.71			1.15	0.86, 1.51	0.3
Believes UK government is making good decisions about COVID-19 control					<0.001	<0.001				
Yes	982 (21.7%)	929 (94.6%)	53 (5.4%)	—	—			—	—	
No	3,553 (78.3%)	2,930 (82.5%)	623 (17.5%)	3.73	2.82, 5.04			1.63	1.08, 2.48	0.021

(Continued)

TABLE 1 | Continued

Characteristic	Total ($N = 4,535$) n %[†]	Accept vaccine ($N = 3,859$) n %[††]	Reject vaccine ($N = 676$) n%[††]	Univariate analysis				Multivariate analysis		
				OR[a]	95% CI[a]	*p*-value	*q*-value[b]	OR[a]	95% CI[a]	*p*-value
Believes UK government tells the truth about COVID-19 and Coronavirus					<0.001	<0.001				
Always	195 (4.3%)	183 (93.8%)	12 (6.2%)	—	—			—	—	
Mostly	1,581 (34.9%)	1,526 (96.5%)	55 (3.5%)	0.55	0.30, 1.09			0.6	0.29, 1.32	0.2
Sometimes	1,415 (31.2%)	1,272 (89.9%)	143 (10.1%)	1.71	0.97, 3.32			1.65	0.81, 3.65	0.2
Almost never	842 (18.6%)	641 (76.1%)	201 (23.9%)	4.78	2.72, 9.23			4.79	2.31, 10.7	<0.001
Never	502 (11.1%)	237 (47.2%)	265 (52.8%)	17.1	9.66, 33.0			8.76	4.15, 19.9	<0.001
Overall health (Self-assessed)						<0.001	<0.001			
Very good	1,347 (29.7%)	1,071 (79.5%)	276 (20.5%)	—	—			—	—	
Good	1,967 (43.4%)	1,736 (88.3%)	231 (11.7%)	0.52	0.43, 0.62			0.64	0.48, 0.85	0.002
Fair	947 (20.9%)	839 (88.6%)	108 (11.4%)	0.5	0.39, 0.63			0.45	0.31, 0.66	<0.001
Bad	226 (5.0%)	180 (79.6%)	46 (20.4%)	0.99	0.69, 1.40			0.63	0.36, 1.09	0.11
Very bad	48 (1.1%)	33 (68.8%)	15 (31.2%)	1.76	0.92, 3.24			1	0.36, 2.58	>0.9
Signs of depression in last 4 weeks						<0.001	<0.001			
Not at all	1,435 (31.6%)	1,235 (86.1%)	200 (13.9%)	—	—			—	—	
Several days	1,730 (38.1%)	1,535 (88.7%)	195 (11.3%)	0.78	0.64, 0.97			0.94	0.69, 1.29	0.7
Half the days	970 (21.4%)	807 (83.2%)	163 (16.8%)	1.25	1.00, 1.56			1.09	0.77, 1.54	0.6
Every day	400 (8.8%)	282 (70.5%)	118 (29.5%)	2.58	1.99, 3.35			1.27	0.82, 1.96	0.3
Smoking in the last 4 weeks						<0.001	<0.001			
None	4,070 (89.7%)	3,525 (86.6%)	545 (13.4%)	—	—			—	—	
Light	198 (4.4%)	148 (74.7%)	50 (25.3%)	2.19	1.55, 3.03			1.33	0.78, 2.21	0.3
Moderate	208 (4.6%)	150 (72.1%)	58 (27.9%)	2.5	1.81, 3.41			1.01	0.60, 1.66	>0.9
Heavy	59 (1.3%)	36 (61.0%)	23 (39.0%)	4.13	2.40, 6.98			2.84	1.25, 6.27	0.011
Type 1 diabetes						0.54	0.62			
No	4,448 (98.1%)	3,783 (85.0%)	665 (15.0%)	—	—					
Yes	87 (1.9%)	76 (87.4%)	11 (12.6%)	0.82	0.41, 1.49					
Type 2 diabetes						0.036	0.052			
No	4,044 (89.2%)	3,426 (84.7%)	618 (15.3%)	—	—					
Yes	491 (10.8%)	433 (88.2%)	58 (11.8%)	0.74	0.55, 0.98					
Asthma						0.3	0.38			
No	3,520 (77.6%)	2,985 (84.8%)	535 (15.2%)	—	—					
Yes	1,015 (22.4%)	874 (86.1%)	141 (13.9%)	0.9	0.73, 1.10					
Lung disease						0.25	0.33			
No	4,233 (93.3%)	3,609 (85.3%)	624 (14.7%)	—	—					
Yes	302 (6.7%)	250 (82.8%)	52 (17.2%)	1.2	0.87, 1.63					

(Continued)

TABLE 1 | Continued

Characteristic	Total (N = 4,535) n %[†]	Accept vaccine (N = 3,859) n %[††]	Reject vaccine (N = 676) n%[††]	Univariate analysis				Multivariate analysis		
				OR[a]	95% CI[a]	p-value	q-value[b]	OR[a]	95% CI[a]	p-value
Cancer						0.32	0.39			
No	4,029 (88.8%)	3,421 (84.9%)	608 (15.1%)	—	—					
Yes	506 (11.2%)	438 (86.6%)	68 (13.4%)	0.87	0.66, 1.14					
Stroke						0.12	0.17			
No	4,351 (95.9%)	3,710 (85.3%)	641 (14.7%)	—	—					
Yes	184 (4.1%)	149 (81.0%)	35 (19.0%)	1.36	0.92, 1.96					
Heart disease						0.73	0.76			
No	4,128 (91.0%)	3,515 (85.2%)	613 (14.8%)	—	—					
Yes	407 (9.0%)	344 (84.5%)	63 (15.5%)	1.05	0.79, 1.38					
Hypertension						<0.001	<0.001			
No	3,092 (68.2%)	2,580 (83.4%)	512 (16.6%)	—	—			—	—	
Yes	1,443 (31.8%)	1,279 (88.6%)	164 (11.4%)	0.65	0.53, 0.78			0.89	0.66, 1.21	0.5
Obesity						<0.001	<0.001			
No	3,755 (82.8%)	3,161 (84.2%)	594 (15.8%)	—	—			—	—	
Yes	780 (17.2%)	698 (89.5%)	82 (10.5%)	0.63	0.49, 0.79			0.99	0.69, 1.40	>0.9
Depression (doctor diagnosed)						0.65	0.69			
No	3,058 (67.4%)	2,597 (84.9%)	461 (15.1%)	—	—					
Yes	1,477 (32.6%)	1,262 (85.4%)	215 (14.6%)	0.96	0.80, 1.14					
Anxiety						0.99	0.99			
No	3,192 (70.4%)	2,716 (85.1%)	476 (14.9%)	—	—					
Yes	1,343 (29.6%)	1,143 (85.1%)	200 (14.9%)	1	0.83, 1.19					
General feelings about vaccines and vaccination						<0.001	<0.001			
No vaccine concerns	3,658 (80.7%)	3,435 (93.9%)	223 (6.1%)	—	—			—	—	
Vaccine concerns	521 (11.5%)	352 (67.6%)	169 (32.4%)	7.4	5.88, 9.29			3.56	2.67, 4.75	<0.001
Vaccine concerns and rejected vaccine offers	356 (7.9%)	72 (20.2%)	284 (79.8%)	60.8	45.6, 81.9			20.6	14.2, 30.3	<0.001
Previous flu vaccine behaviors						<0.001	<0.001			
Always/Usually gets flu vaccine	2,725 (60.1%)	2,610 (95.8%)	115 (4.2%)	—	—			—	—	
Sometimes gets flu vaccine	751 (16.6%)	637 (84.8%)	114 (15.2%)	4.06	3.09, 5.34			1.89	1.34, 2.66	<0.001
Does not get flu vaccine	1,059 (23.4%)	612 (57.8%)	447 (42.2%)	16.6	13.3, 20.8			5.39	4.01, 7.29	<0.001
Household income						<0.001	<0.001			
Less than £15,000	595 (13.1%)	467 (78.5%)	128 (21.5%)	—	—			—	—	
£15,000–£24,999	908 (20.0%)	756 (83.3%)	152 (16.7%)	0.73	0.56, 0.95			0.66	0.44, 0.98	0.041
£25,000–£39,999	1,183 (26.1%)	1,011 (85.5%)	172 (14.5%)	0.62	0.48, 0.80			0.69	0.46, 1.03	0.068
£40,000–£59,999	895 (19.7%)	797 (89.1%)	98 (10.9%)	0.45	0.34, 0.60			0.41	0.26, 0.64	<0.001

(Continued)

TABLE 1 | Continued

Characteristic	Total (*N* = 4,535) n %[†]	Accept vaccine (*N* = 3,859) n %[††]	Reject vaccine (*N* = 676) n%[††]	Univariate analysis				Multivariate analysis		
				OR[a]	95% CI[a]	*p*-value	*q*-value[b]	OR[a]	95% CI[a]	*p*-value
£60,000–£99,999	684 (15.1%)	595 (87.0%)	89 (13.0%)	0.55	0.40, 0.73			0.42	0.26, 0.68	<0.001
More than £100,000	270 (6.0%)	233 (86.3%)	37 (13.7%)	0.58	0.38, 0.85			0.40	0.21, 0.75	0.005
Suffered financial hardship during pandemic (Self-assessed)						<0.001	<0.001			
no	3,591 (79.2%)	3,140 (87.4%)	451 (12.6%)	—	—			—	—	
yes	944 (20.8%)	719 (76.2%)	225 (23.8%)	2.18	1.82, 2.60			1.02	0.76, 1.36	0.9
Political opinions						<0.001	<0.001			
Floating	1,471 (32.4%)	1,173 (79.7%)	298 (20.3%)	—	—			—	—	
Conservative	1,080 (23.8%)	853 (79.0%)	227 (21.0%)	1.05	0.86, 1.27			2.05	1.51, 2.80	<0.001
Liberal	1,984 (43.7%)	1,833 (92.4%)	151 (7.6%)	0.32	0.26, 0.40			0.3	0.22, 0.41	<0.001
Postcode area						0.55	0.62			
London	436 (9.6%)	374 (85.8%)	62 (14.2%)	—	—					
East Midlands	366 (8.1%)	317 (86.6%)	49 (13.4%)	0.93	0.62, 1.39					
East of England	461 (10.2%)	401 (87.0%)	60 (13.0%)	0.9	0.62, 1.32					
North East	361 (8.0%)	314 (87.0%)	47 (13.0%)	0.9	0.60, 1.35					
North West	515 (11.4%)	426 (82.7%)	89 (17.3%)	1.26	0.89, 1.80					
Northern Ireland	46 (1.0%)	36 (78.3%)	10 (21.7%)	1.68	0.75, 3.44					
Scotland	316 (7.0%)	260 (82.3%)	56 (17.7%)	1.3	0.87, 1.93					
South East	644 (14.2%)	553 (85.9%)	91 (14.1%)	0.99	0.70, 1.41					
South West	482 (10.6%)	409 (84.9%)	73 (15.1%)	1.08	0.75, 1.56					
Wales	263 (5.8%)	226 (85.9%)	37 (14.1%)	0.99	0.63, 1.53					
West Midlands	345 (7.6%)	291 (84.3%)	54 (15.7%)	1.12	0.75, 1.66					
Unknown	300 (6.6%)	252 (84.0%)	48 (16.0%)	1.15	0.76, 1.73					

[a]OR, Odds Ratio; CI, Confidence Interval; [b]False discovery rate correction for multiple testing; [†]% of total; [††]% of group.

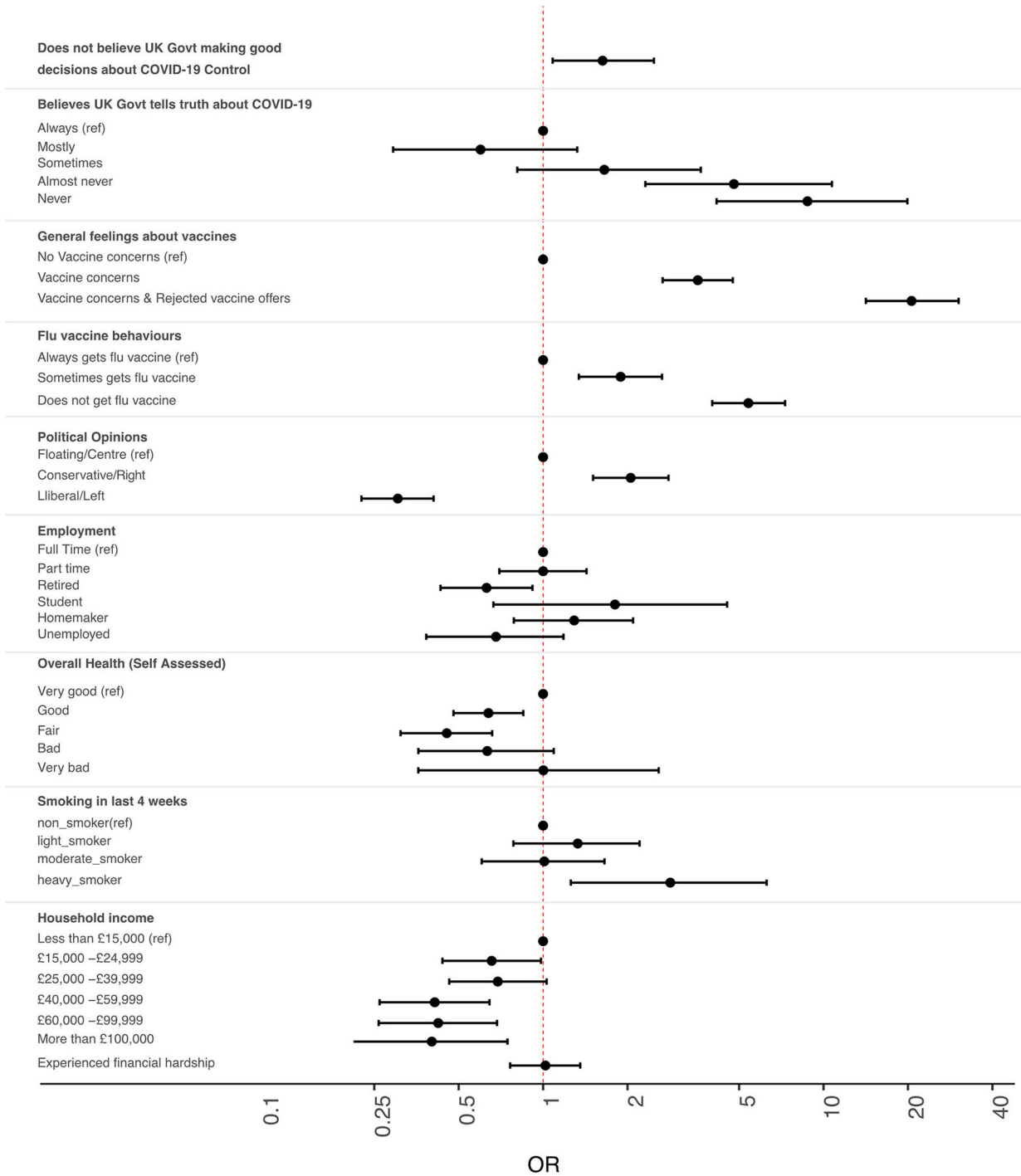

FIGURE 1 | Intention to refuse offers of COVID-19 vaccination among members of the UK public. Odds ratio (OR) estimates [points] and 95% confidence intervals [solid lines] indicate relative intention to refuse vaccine. ORs above 1.00 indicate increased OR of rejecting vaccines. Values below 1.00 indicate increased intention to accept vaccines. All ORs are fully corrected for other covariates. Covariates that had no significant association with intention to vaccinate are not shown, but are fully described in **Table 1**.

"Rushed, not properly tested vaccines from companies where there is personal financial gain for govt ministers and friends, also the granting of immunity against liability for adverse drug reactions to all who are developing vaccines, they have been trying to develop a corona virus [sic] vaccine for over 20 years, without success, now suddenly the miracle happens?"

Some also questioned whether there was any real need to vaccinate the population when COVID-19 was a relatively mild disease in the majority of people and had a low overall mortality rate (REF04).

"the virus is mostly a mild disease. Statistics for Covid don't support general vaccination."

"To bring the country to a standstill over a virus with a 98% recovery rate and a death rate one year above the national life expectancy I believe the reaction to it has been grossly over the top I therefore it goes against every sinew in me to get the vaccine I am not scared of the virus and would rather my body battle it naturally and I'm not prepared to have have something that has been rushed through with unknown long-term or short-term side effects put into my body"

"This is a [sic] untested RNA vaccine. Knowone [sic] knows the long terms [sic] effects of this. Plus this virus has a 99.8% survival rate. Therefore, vaccines are not needed"

"Too soon to assess effectiveness or side effects. Plus the virus is mostly a mild disease. Statistics for Covid don't support general vaccination."

Confidence in Vaccines

The majority of respondents always or usually had a yearly vaccination against influenza virus (n = 2,725, 60.1%). Individuals who reported either never (OR 5.39, 95% CI 4.01–7.29, $p < 0.001$) or only sometimes (OR 1.89, 95% CI 1.34–2.66, $p < 0.001$) having a seasonal influenza vaccine were less likely to accept COVID-19 vaccines than those who did so every year. Members of both groups described how they informed their decisions with reference to their use or experiences of flu vaccines. On the side of those who would accept COVID-19 vaccines, topic ACC01 included comments that indicated how some participants saw little difference between the COVID-19 vaccines and those they already used for flu.

"I sometimes have the flu jab. Same difference to me"

"Same reason I have a flu jab every year–to avoid getting the virus"

Some participants who planned to get vaccinated (ACC15) reflected on the maxim that "Prevention is better than cure" and cited the successes of previous vaccination campaigns

"When I was young polio was common and life threatening. Vaccination changed all that. Presumably this vaccination will do the same for Covid."

"the only disease to be eradicated is small pox [sic] the rest are managed by better treatments and vaccines"

Meanwhile in the other group (REF07), some participants reflected on their own negative experiences of flu vaccines, focussing on their perceptions of how these had previously harmed their health.

TABLE 2 | Topics summarizing reasons for intending to refuse a COVID-19 vaccine.

Topic[a]	Title	n.0.3[b]
REF01	Healthy, so can rely on own immune system	25
REF02i	No trust in government, pharma industry and vaccine	6
REF02ii	Mistrust of pharma and government in context of rapid development of vaccines	21
REF02iii	Vaccines have not been tested enough	22
REF02iv	Not enough testing, specific concerns of adverse reactions and unforeseen complications	12
REF03	Concerns about unknown safety and effectiveness	11
REF04	Lack of need for COVID-19 vaccine given low overall mortality rate	18
REF05	Undecided and/or concerned about side-effects and personal medical history	21
REF06	Risks of relatively untested vaccine vs. benefits of vaccinating generally healthy people	10
REF07	Contextualizes COVID-19 vaccines in personal history of flu vaccines and adverse reactions	19
REF08i	Concerns about side effects	6
REF08ii	Concerns about long term side effects	16
REF09	Previous bad reactions to vaccines and/or allergies to penicillin	18
REF10	Concerned about quality of research during rapid vaccine development	25
REF11	Pregnant, breastfeeding, ineligible or unwilling to be vaccinated	13
REF12	Potentially willing to be vaccinated, but expressed hesitancy or concerns	29
REF13	Allergies and reactions to medicines	24
REF14	References to previously failed trials, legal cases and medical scandals	9
REF15	Ethical or medical concerns about derivation, formulation and effects of vaccine	12
REF16	[Fewer than five quotes with theta > 0.3]	4

[a] *Roman numerals indicate sub-topics with correlation > 0.2.*
[b] *n.0.3 Number of quotes assigned to topic with theta score > 0.3.*

"The flu jab caused m.e [myalgic encephalitis] in 2009. I want to build my exposure naturally as when my health improves I will be back at the allotment [a plot of land rented by an individual for growing vegetables]. I understand a small part of virus helps your body fight and remember how to fight in future. I just question what else is in them now. People have glandular fever and are ok. I think it was that and the combination of the vaccine that didn't give my body a chance. My nanny has also recently said. Bare [sic] in mind she's 80 she doesn't feel so well after this recently [sic] flu jab and isn't recovering…"

"I had my 1 and only Flu jab back in 1974 and suffered the worst bout of Flu soon after, 5 weeks off work, over 1 stone lost in weight. I've not had a Flu jab in the ensuing 46 years, and I've never had the Flu since either, so no, I will not be having the Covid-19 vaccine!"

TABLE 3 | Topics summarizing reasons for intending to accept a COVID-19 vaccine.

Topic[a]	Title	n.0.3[b]
ACC01	Recognizes value of vaccinations and compares COVID-19 to flu vaccines	37
ACC02i	Wants to get back to normal life	>100
ACC02ii	[Fewer than five quotes with theta > 0.3]	1
ACC03	Aware of risks and concerns of others, but on balance sees benefit of COVID-19 vaccines	39
ACC04i	Wants to protect loved ones / vulnerable people, and travel to see friends and family	55
ACC04ii	Protect self and others	7
ACC04iii	[Fewer than five quotes with theta > 0.3]	1
ACC04iv	Wishes to mix in social, cultural and work contexts	7
ACC04v	[Fewer than five quotes with theta > 0.3]	0
ACC05i	[Fewer than five quotes with theta > 0.3]	0
ACC05ii	[Fewer than five quotes with theta > 0.3]	0
ACC05iii	[Fewer than five quotes with theta > 0.3]	2
ACC05iv	To prevent contracting and spreading infection	8
ACC05v	[Fewer than five quotes with theta > 0.3]	1
ACC06	Trusts the science, scientists and the scientific process	52
ACC07	Has some concerns, but on balance believes acceptance the correct choice	13
ACC08	To help build herd immunity	58
ACC09	Recognizes vaccination as a social responsibility and public good	27
ACC10	Healthcare professionals and/or visit care homes	20
ACC11	Responsibilities to the wider community	17
ACC12	Works in NHS, Schools, Pharma and with vulnerable people	34
ACC13	Participant and/or family member in high risk group because of age or medical condition	54
ACC14	Vaccination to be safe and make others safe, some with negative sentiments on UK government	10
ACC15	Prevention better than cure, referencing success of historical vaccine programmes	13
ACC16	It is the sensible and responsible thing to do	72

[a]*Roman numerals indicate sub-topics with correlation > 0.2.*
[b]*n.0.3 Number of quotes assigned to topic with theta score > 0.3.*

The majority of participants (3,658, 80.7%) expressed general confidence in vaccines. Among those who were vaccine hesitant, 521 (11.5%) had concerns about the usefulness of vaccines and a further 356 (7.9%) not only shared these concerns, but had also rejected some or all vaccines they had been offered in the past.

Participants who had concerns about vaccines in general and who either had (OR 20.6, 95% CI 14.20–30.30, $p < 0.001$) or had not (OR 3.56, 95% CI 2.67–4.75, $p < 0.001$) previously turned down offers of vaccines against other diseases, were all more likely to indicate intention to refuse COVID-19 vaccines. Participants who planned to accept COVID-19 vaccines spoke of how they recognized the value of vaccinations (ACC01, ACC05 & ACC14) and of how they accepted that vaccination was a safe and effective process that could help establish herd immunity (ACC08).

> *"I regard it as my personal contribution to the overall health of the population. It is necessary for herd immunity in the true sense of the phrase"*

> *"Because herd immunity is essentially a myth: measles, TB, polio, smallpox- none of these (and others) were ever eliminated from a population by herd immunity [presumably meaning by uncontrolled natural spread of infection], but by vaccination."*

A number of participants made the points (ACC16) that they felt that vaccinating oneself was the "sensible and responsible" thing to do, that (ACC11) these decisions reflected responsibilities to dependents or the wider community in the pursuance of (ACC01 and ACC09) public good through (ACC09) common sense.

> *"Because it's the right thing to do to see [an] end of how we are all currently constrained"*

> *"To protect myself, to reduce the amount of virus in the community, to free myself from isolation"*

> *"Because it's stupid and irresponsible not to unless there's a genuine medical reason why you can't."*

> *"We live in a society, each person in that society have [sic] obligations to each other. By having the vaccine you are fulfilling one of those obligations. Each and every person must do what is needed to fight this pandemic no matter what it is otherwise we will never get it under control."*

Some also stressed (ACC04) that vaccination would protect them and others; including loved ones and social contacts who were vulnerable. For many this was key to returning to normal life (ACC02) and ending social distancing (ACC04).

> *"Protect myself and protect those that can't be vaccinated. Hopefully enable me to see friends and family again properly and hug them. I haven't hugged my mum, dad or friends since the start of March and it really hurts."*

> *"I don't want to get sick and I want my freedom back. I want to see my children and friends, go to the movies or theatre, travel. Have real galleries not online ones. Use public transport etc. without fear."*

> *"it will be the only way to get life back to normal"*

> *"I should like to live a normal life. I should like to go on holiday. I should like to sing with other people. I live in London and I'd like to use the Tube, go to the theatre, go to exhibitions."*

Among the group who planned to accept COVID-19 vaccines, some mentioned that whilst they were not without concerns, they had decided that on balance they could see a net benefit of vaccination (ACC03 and ACC07).

"I feel I probably should though I am nervous about how 'young' the vaccine is. I am aware all stages have been covered in development but it has only been trialed/in use for a very short time. No one has any idea of actual long term side effects. Most vaccines I'd have would have been in use for years. What if we all regret it later? Especially the newer RNA technology. I am more confident in the Oxford style vaccine."

"I don't think any COVID vaccine will be completely safe as there's no decades worth of data to assess the long term consequences. Howeve,r on balance, having the vaccine will be safer than experiencing covid (or passing it on)."

Others who were willing to be vaccinated explained that they would get vaccinated because they had roles as teachers, healthcare workers or other frontline workers (some with medical vulnerabilities) and/or regularly spent time with people who were vulnerable or in care homes (ACC10 and ACC12).

"I work in healthcare and have severe asthma. I don't want worse lung function or to pass this on to vulnerable relatives and patients. I want tier 3 [social distancing and lockdown] restrictions to end. I don't want more lockdowns."

"I am vunerable [sic] due to my lung problems. The disease could be fatal for me. I work with very vunerable patients. My mother in law lives with us shes [sic] 85"

"I am on drugs that suppress my immune system and feel quite vulnerable as I work in school where we can not socially distance from the children"

Some participants who said they would refuse the offered vaccines clarified that there were in fact circumstances under which they would get vaccinated (REF12). For some, the need to be vaccinated in order to be permitted to travel could be a key influencing factor, whilst others wanted to wait to see longer term effects in others. Still more said that they probably would get vaccinated, but would not be "happy" about it (referencing the specific wording of the survey question, see methods).

"I will if I'm coerced by the government to travel but I wouldn't be happy about it. I'd simply rather not and as I'm low on the list I will wait."

"Has only been tested on [a] small demographic. Company that developed it [has] no vaccine experience. Will happily get London [presumably University of Oxford/Astra-Zeneca] vaccine 2021 after [it is] rolled out to [a] wider group. Plus had Covid recently so [my] assumption is [that I] have antibodies at the moment."

"I think it's too soon/ quick-has [Prime Minister] boris [Johnson] had it yet? I think it'll be a while before I get called up so I'll reconsider then."

Several topics (REF02, REF08, REF09, REF10, REF13, REF14) meanwhile triangulated with a general mistrust of vaccines and vaccine research. In topic REF08, participants expressed concerns about the potential for long-term side effects or adverse reactions, especially in the context of the track-records of various pharmaceutical companies.

"No evidence that the "vaccine" would actually make a difference at this stage and is unproven in the longer term. I am not statistically at risk and therefore there appears to be more potential issues from the vaccine than from the infection. As more data and evidence emerges over time I will review this."

"Because I don't feel confident that there's been an adequate monitoring period after administration. Seeing politicians and the CSO [Chief Scientific Officer] say they would have the vaccine whilst it was still in phase 3 and unapproved destroyed my confidence in it. Pfizer's track record and the fact they have been granted legal immunity also concerns me."

"untested, unproven, vaccine manufacturers have been given indemnity from prosecution for any harm the vaccine may cause, developed far too fast by companies with a track record of fraud and harm, no long term studies of a brand new vaccine type etc."

"[I am] not convinced at the reassurances by all those involved with their own agendas. Other vaccines have a history of out of court settlements. There is no chance I would touch this vaccine for at least 5–10 years."

Further to comments indicating a general mistrust of pharmaceutical companies (REF02), some quotes (REF13 and REF14) went on to reference notorious historical medical scandals, including those related to the drugs Thalidomide and Benoxaprofen.

"Approval too rushed. I grew up with Thalidomide victims and was myself prescribed Opren [Benoxaprofen], which had to subsequently be withdrawn."

"Until the vaccine has been properly tested... I am of the thalidomide generation... I would be very wary."

Some participants either had personal experiences (REF09) of adverse reactions to medicines or vaccines that had shaped their opinions of COVID-19 vaccines, or were otherwise (REF15) concerned that they could have reactions resulting from pre-existing conditions.

"[I am] Slightly concerned and will take advice from GP as have had allergic reaction to flu vaccine and penicillin in the past. More than willing to have vaccine if reassured on likely adverse reaction."

"I had a very bad reaction to a normal flu jab that resulted in going to A&E due to dehydration. The symptoms I had are very similar to the symptoms of covid"

"I have Lupus, Hughes Syndrome/APS/Antiphospholipid Syndrome, Sjogrens, a slow thyroid/Hashimotos, Psoriatic Arthropathy and STEVENS JOHNSON Disease, I have dire reactions to drugs, and have an allergy to antibiotics, serious allergies... so today we find out that people like me should not have the Pfizer vac, I have had lot of vacs in my life but no more now."

Some participants also mentioned their ethical concerns about derivation, formulation and effects of COVID-19 vaccines (REF15, REF08, and REF09)

"Vaccines developed using aborted foetal cells are unethical. If there is a vaccine that has been developed without using aborted foetal cells in any part of the manufacture or testing processes, I would be happy to receive that vaccine."

"I react badly to vaccinations. The contents of them are more harmful than the good they might do."

"Will get oxford vaccine when licensed but I have concerns that the Pfizer vaccine utilises muscle to make protein from rna [sic] and that there is no long term back data to show whether this elicits any side effects e.g.; autoimmune concerns or whether it is totally safe. If I were 80 and high risk I would have it."

Overall Health

Participants who rated their general health as 'good' (OR 0.45, 95% CI 0.31–0.66, $p = 0.002$), "fair" (OR 0.45, 95% CI 0.31–0.66, $p < 0.001$) or "bad" (OR 0.63, 95% CI 0.36–2.58, $p = 0.11$) were all less likely to refuse COVID-19 vaccines than the healthiest ("very good") group. These effects were independent of other covariates including age and pre-existing, doctor diagnosed health conditions. In topic REF01, a number of participants who intended to refuse offers of COVID-19 vaccines explained how they felt they could rely on the strength of their healthy immune system or health behaviors to protect them from COVID-19.

"Not tested long enough, insufficient test data available, Mnra [sic] vaccine never been licenced before, no trust in the current testing data, I look after myself, I eat well/healthy, exercise, good immune system."

"My diet and lifestyle are good good [sic] and hence immune system is strong"

"I have an underlying health condition and vaccinations and medications can compromise my immune system rather than support it. I am not opposed to vaccinations, just cautious and believe in supporting the immune system as much as possible through diet, exercise [sic] and where necessary supplementation i.e., vitamin D"

The concerns of some participants (REF05) reflected a position where they may eventually decide to accept COVID-19 vaccines, but only after further information became available. For some this was guided by their personal medical concerns and overall health, while others who were generally healthy (REF06) found themselves trying to evaluate the risks of accepting a relatively untested vaccine against the benefits of being vaccinated.

"[I have] Multiple autoimmune diseases, vaccine not tested on people like me. No evidence that immune response to vaccine won't cause autoimmune flare or long term immune dysregulation. Not an anti-vaxxer, just a chronic illness sufferer."

"I am undecided, I would like to see more safety data as it is rolled out."

"I would like to see the result of studies into how long antibodies last post vaccination and also learn more about how people are reacting to it. So my answer is NO I won't take it as soon as it becomes available. By the time my turn comes my answer might well be YES."

"I do not take the flu jab either... but I also don't take any other medication unless it is essential. I do not feel that the long term side effects of things like the flu jab or covid vaccine have been fully investigated or understood. I expect that my usually quite good immune system would handle a coronavirus- if it hasn't already. It may make sense for people who have been shown to be at higher risk of complications to take the vaccine though. Also, I am pregnant and the impact of the vaccine on fetuses has not been investigated."

Others meanwhile considered themselves to be ineligible because they belonged to special demographic categories (REF11 and REF13).

"I am breastfeeding. I will get vaccinated if it is safe for my baby or when I stop breastfeeding."

"Trying to get pregnant. I will be happy to get the vaccine once more evidence is provided that it is not harmful to women trying to conceive/pregnant"

"I would get vaccinated if I could trust the vaccine and am not an anti vaccer [sic] but I have concerns about the current vaccine in particular the warning to fertile or pregnant women as well as breastfeeding mothers..... I am going to fit into one of these categories for many yrs to come!"

"I suffer from an ongoing allergy problem and have to carry adrenaline at all times. I understand that this means that I cannot have the Pfizer vaccine. I'll look at the others when they are released."

There was no evidence for a difference in COVID-19 vaccine acceptance among groups with specific medical conditions (as diagnosed by a doctor), those who were disabled, or who had recent signs of depression. Ethnicity was not associated with vaccine intention in this analysis, though we highlight the very small number of respondents from ethnic minority groups and lack of granularity in analysis of this variable. Heavy smokers were also more likely to refuse (OR 2.84, 95% CI 1.25–6.27, $p = 0.011$) offered COVID-19 vaccines.

Employment Status and Income

We found that retirees were less likely to decline a COVID-19 vaccine compared to those in full time employment (OR 0.63, 95% CI 0.43–0.92, $p = 0.016$) but there was no evidence for similar differences in other employment categories. In topic 13, some respondents identified their being older as a key factor in their decision to accept offers of COVID-19 vaccines (ACC13). Others referenced their personal experiences of the impacts

of now-vaccine-preventable diseases such as measles (ACC13 and ACC14).

"I'm in the older age group and it's sensible to reduce my risk"

"Because of my age and having asthma. Also, my husband has angina, so to help protect him."

"I was born in the 1950s when measles, polio caused severe illness and vaccination changed that"

"I still remember when smallpox was finally beaten. I had an older cousin who was blind and brain damaged because her mother caught measles when pregnant."

Participants in the lowest household income bracket (< £15,000 per annum) were less likely to accept offers of COVID-19 vaccines than any other income group (**Table 1**). Experiences of financial hardship during the pandemic were reported by 20.8% ($n = 944$) of participants, but this was not associated with vaccination intentions (either in the main analysis, or in sub-analyses where [i] income was removed from the model and [ii] where an interaction between income and hardship was included).

Political Views

The political views of respondents were varied, with 43.7% ($n = 1{,}984$) describing themselves as "Liberal/Left," 23.8% ($n = 1{,}080$) as "Conservative/Right" and 32.4% ($n = 1{,}471$) as "Floating/Center" (**Table 1**). Compared to those whose political views were central, participants on the political left (OR 0.30, 95% CI 0.22–0.41, $p < 0.001$) were less likely to refuse a vaccine and those on the political right (OR 2.05, 95% CI 1.51–2.80, $p < 0.001$) were more likely to refuse a COVID-19 vaccine when offered.

DISCUSSION

The results of this online survey indicate that acceptance of vaccines was, from the very outset of the UK's COVID-19 vaccination campaign, likely to be very high in all regions of the UK. Around 85% of respondents indicated that they were willing to be vaccinated when the survey took place in December 2020. There appeared to be no relationship between intention to be vaccinated and geographical location, gender, educational achievement, disability, any of a range of specific pre-existing health conditions or experiences of having had COVID-19 symptoms. Participants from wealthier households were more likely to accept vaccines and previous studies have linked lower income to higher levels of uncertainty about COVID-19 vaccines in the UK (19) and elsewhere (20). An association between reduced uptake of other vaccines and lower incomes has also been seen in other studies in the United States and the UK (21, 22).

Other studies in the UK have found that older adults were more likely to accept a COVID-19 vaccine (19, 23) but after adjusting for covariates we found no clear association between age and COVID-19 vaccine acceptance. We did however observe that participants who were retired were also more likely to accept vaccination, which may act as a proxy for the same observation about older adults. No other employment status was associated with intention to accept or refuse vaccination.

Despite a known increased risk of severe COVID-19 amongst those with a number of pre-existing medical conditions (24) we did not see any difference in COVID-19 vaccine acceptance between those with and without doctor diagnosed comorbidities. It is therefore possible that the overall perception of health status is more likely to influence respondents' attitudes toward vaccination rather than their specific medical history. We saw an association between vaccination and self-reported recent general health, where those who felt that their general health was "good" or "fair" were more likely to accept vaccines than those who said "very good." This fits with observations from the qualitative analysis that some participants felt that they didn't need to be vaccinated because of their good general health and strength of their immune system. Heavy current smokers indicated that they were more likely to decline a COVID-19 vaccine than current non-smokers. Smoking is linked to a raft of risk taking behaviors, impaired decision making and poor risk evaluations of the future consequences of actions (25) and these considerations could explain the much higher odds of refusing vaccines that we observed among heavy smokers. Mangtani et al. (27) recently showed that uptake of influenza vaccines differed by smoking status, whilst Jackson et al. (26) highlighted that current smokers were more likely to be undecided or unwilling to receive a COVID-19 vaccine. The latter study also showed that smokers were more likely to have negative feelings toward vaccines, citing reasons that broadly echoed the concerns raised by the group of participants who planned to refuse vaccines in this study.

The diminishment of public trust in the UK government has been a major concern during the COVID-19 pandemic and we have previously highlighted how generalized mistrust, concerns about the transparent use and communication of evidence and insights into decision-making processes affected perceptions of the UK government's early pandemic response (28). In the April 2020 survey, we found that 42.3% of study participants thought that the government always or nearly always told the truth about COVID-19 and in this survey this remained relatively unchanged at 39.2%. Confidence in the quality of government decision making had however changed substantially between the two surveys. In April 2020, 52.7% of participants said that the government was making good decisions (28), but in December 2020 just 21.7% felt this way. A poor opinion of government decision making (and also low trust in the truthfulness of government) was associated with increased odds of refusing COVID-19 vaccines (**Table 1**). Some respondents who talked about the government in the context of trust did however make a clear delineation between their faith in the government and that in the health service and/or science and scientists.

We also observed that participants who identified as having right-wing political views were significantly less likely to accept a COVID-19 vaccine, even after adjusting for potential socio-demographic covariates. The opposite was true of participants from the political left. A survey conducted in the US also found that those whose political view was conservative/right were less likely to accept vaccines (29). This finding may be somewhat

surprising because the UK's COVID-19 response was led by a Conservative government and we might have expected that supporters of the incumbent government would most positively support their health initiatives. Anti-vaccination sentiments have however been linked with support for populist political parties, with both phenomena being "driven by similar dynamics: a profound distrust in elites and experts" (29). The rise of populist narratives, and particularly the UK government's courtship of a populist right wing during the Brexit period (2016–2021) may therefore have led to the consolidation of political but not policy support amongst certain sections of the Conservative electorate.

Previous behaviors and experiences with regards to utilization of vaccines against seasonal influenza were associated with increased uptake of COVID-19 vaccines. This finding has also been seen in other studies in the UK (19, 23), Australia (30) and (in some demographic groups) in the United States of America (31). Perhaps unsurprisingly, our results also identified that participants' levels of generalized vaccine hesitancy and previous refusals of offered vaccines associated with respectively 3.6- and 21-times greater odds of refusing COVID-19 vaccines, compared to those who were confident in vaccines.

During the pandemic, the significance of so-called "infodemics" and of misinformation, rumor and unscientific beliefs, has been at the forefront of public debates (32). Underlying these discussions is the assumption that hesitation toward or refusal of public health interventions is grounded in misconceptions or poor information. We found only scant evidence within our corpus of free text quotes to support concerns that intentions to refuse COVID-19 vaccines were potentially driven by effects relating to misinformation or pseudoscience. Instead, a key element in our respondents' considerations was trust in the product, with responses amongst both those who said they would and those who say they would not take a COVID-19 vaccine gravitating around questions about the quality and safety of the vaccines. This supports critical insights into vaccine hesitancy which reject "knowledge deficit" framings of the problem, recasting it instead into a question of trust in scientific expertise (33).

Among those participants who said they would not accept a COVID-19 vaccine, we found that their primary concerns were highly specific to the vaccine development process, to issues relating to the rapidity of the vaccine trials & the novelty of mRNA-based vaccines; as well as to the relative absence of knowledge about the long-term effects and safety including in pregnancy and breastfeeding. Whilst the seemingly low penetration of misinformation in our corpus of text may have been biased downwards by the limited representativeness of our sample, empirical social scientific research on rumors, hesitancy and trust in medical research across different contexts has shown similar results (34). In the context of the concerns of this study's participants, COVID-19 vaccine hesitancy appeared to be framed by legitimate concerns about the perceived unavailability of substantive scientific data to support claims that the vaccines were safe and (possibly to a lesser degree) effective. It is notable that one COVID-19 vaccine had received licensure in the UK at the time of the survey and that specifically long-term safety issues were a focus point of public discussion.

The safety of vaccines is a prevalent topic in the debate on vaccine hesitancy (35–37). Reduced confidence may be heightened when limited scientific data are available, for instance in the case of investigational, experimental, and new vaccines used during the response to epidemics (38). Some respondents claimed that whilst they would not accept a vaccine at present, they might possibly do so in the future, for example when there was a better understanding of potential adverse events following vaccination in other members of the population. The timing of data collection is salient here, as our respondents' reflections show the particular considerations surrounding deployment of a new vaccine during a health emergency. Indeed, this desire to defer vaccination reflects similar observations made during studies on the acceptance of a vaccine against Ebola virus in Sierra Leone (39). Some governments even made decisions to defer COVID-19 vaccination at the level of national policy (40); for instance, by delaying the commencement of COVID-19 vaccination programmes whilst observing the impacts of programmes underway in countries with a higher burden of disease (40).

If concerns around vaccination were very specifically related to questions about vaccine development, then reflections on willingness to take the vaccine amongst our respondents were rooted in expressions of social responsibility and a vision of the public good. Many respondents focused on the desire to return to "normality," to be able to see family and friends, to resume social activities and to be able to travel again. These motives for willingness to be vaccinated with a novel vaccine represent a complex interaction between altruistic actions and self-interest that have been reported by others participating in experimental studies (41, 42).

Key limitations of this study were that it was non-representative and that the sampling-method was not random; meaning that the study findings are not generalisable either in the UK or elsewhere. We caution in particular that whilst vaccine dis- or mis-information did not appear to be a major influencer of vaccine choice in this UK cohort, this may not be the case in other jurisdictions. The study's participants were disproportionately likely to be highly educated, white and aged over 50 years and there was very limited participation in the 18–34 age group. Ethnic minority groups are at greater risk from COVID-19 (24, 43) and are also less likely to report that they will accept COVID-19 vaccination (44) but these groups were under-represented among those responding to the survey. Facebook's advertising policies preclude the targeting of boosted posts to specific ethnic minority groups, and we were therefore unable to influence the degree to which the advert was seen by, or engaged with by members of ethnic minority groups. The study was observational and causal links between the outcomes and statistically associated explanatory variables cannot be assumed. Additionally, covariates which were not included in the study, or any that were misclassified, could have led to residual confounding. As the study relied on self-reported information, there was scope for response bias, although we designed the questions to minimize this wherever possible. Finally, whilst the STM analysis is fully reproducible using statistical software, the assignment of topic names was performed

manually; albeit only after a process of discussion and consensus that included all authors of this work. Finally, we acknowledge that the study design allowed for a large sample size which favored a broad representation of public sentiment, but that this may not have provided the same depth as a more comprehensive qualitative survey.

Our embedded mixed-methods analysis highlights groups that may be less engaged with the vaccination program and also provides a more detailed exploration of the complex factors and considerations that influenced decision-making among those who planned to either accept or reject the offered vaccines.

We suggest that in the context of the COVID-19 pandemic, levels of public complacency about SARS-CoV-2 vaccines were very low; whilst the large scale, well organized and equitable NHS-led deployment of vaccines in the UK meant that convenience was high. The majority of respondents to this survey reported on how they intended to accept offers of vaccination, suggesting that confidence was high, regardless of the many unknowns. The dominant theme among all topics relating to vaccine acceptance was that there was a need to restore normality, and for individuals to participate in the social good of vaccination by protecting themselves, their loved ones and others in their communities.

Reasons for refusing offered vaccines were more diverse, but notably focussed on legitimate questions about the safety and efficacy of vaccines, the speed of their development cycle, whether there was a real need for a vaccination program and to a lesser extent on whether the government and pharmaceutical companies had hidden motivations. There was no evidence of widespread misinformation or factors relating to an infodemic having influenced the decisions of many participants.

Engaging with public perceptions of a newly developed vaccine, deployed at the height of a health emergency, we question whether the dominant narratives of vaccine hesitancy are misconceived as primarily (or dominantly) being driven by "fake news," misinformation and disinformation on an epidemic scale (infodemics). Whilst we fully recognize the importance of combating misinformation, we propose that efforts to maintain high levels of vaccine confidence should not neglect to contend with legitimate concerns about the lack of transparency about the scientific process of vaccine development. Public engagement should therefore attend to deeper questions of (mis)trust in science and leadership. In order to maximize uptake, the vaccination programme should leverage the sense of altruism, citizenship and collective responsibility that motivated many of our participants to get vaccinated.

It should be noted that this study was conducted in December 2020, at the start of the mass vaccination campaign in the UK. Current attitudes to vaccination may have subsequently changed, but the aim of this paper is to contend with perceptions of a novel vaccine being prepared for deployment at the height of a health emergency. We reiterate the call of Scheinerman and McCoy **(author?)** (45) to address these issues through effective engagement with the public through a process of transparency, ethical reasoning and both formal & informal deliberation (45).

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: LSHTM Data Compass: https://doi.org/10.17037/data.00002337.

ETHICS STATEMENT

This study was reviewed and approved by the Research Ethics Committees of the London School of Hygiene & Tropical Medicine and the World Health Organization (ref: CERC.0039B). The data were fully anonymous and the study team were unable to identify any respondents. The respondents provided informed consent at the start of the survey by means of ticking a box on the web-form. All questions in the survey were optional, meaning that participants could skip questions if they did not want to divulge specific data. Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

AUTHOR CONTRIBUTIONS

CR, HB, NR, RE, LE, and SL conceptualised the study. CR curated the data. CR, HB, LE, and SL performed the analysis and wrote the manuscript. All authors designed the survey and contributed to the article and approved the submitted version.

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COVID-19 Testing in Sweden During 2020–Split Responsibilities and Multi-Level Challenges

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Sweden's use of soft response measures early in the COVID-19 pandemic received a good deal of international attention. Within Sweden, one of the most debated aspects of the pandemic response has been *COVID-19 testing* and the time it took to increase testing capacity. In this article, the development of and the debate surrounding COVID-19 testing in Sweden during 2020 is described in detail, with a particular focus on the coordination between national and regional actors in the decentralised healthcare system. A qualitative case study was carried out based on qualitative document analysis with a chronological presentation. To understand COVID-19 testing in Sweden, two aspects of its public administration model emerged as particularly important: (i) the large and independent government agencies and (ii) self-governing regions and municipalities. In addition, the responsibility principle in Swedish crisis management was crucial. Overall, the results show that mass testing was a new area for coordination and involved a number of national and regional actors with partly different views on their respective roles, responsibilities and interpretations of the laws and regulations. The description shows the ambiguities in the purpose of testing and the shortcomings in communication and cooperation during the first half of 2020, but after that an increasing consistency among the crucial actors. During the first half of 2020, testing capacity in Sweden was limited and reserved to protect the most vulnerable in society. Because mass testing for viruses is not normally carried out by the 21 self-governing regions responsible for healthcare and communicable disease prevention, and the Public Health Agency of Sweden stated that there was *no medical reason* to test members of the public falling ill with COVID-like symptoms, the responsibility for mass testing fell through the cracks during the first few months of the pandemic. This article thus illustrates problems associated with multi-level governance in healthcare during a crisis and illustrates the discrepancy between the health service's focus on the individual and the public health-oriented work carried out within communicable disease control.

Keywords: COVID-19 testing, COVID-19 policy, mass testing, population-wide testing, Sweden, government steering, local policy

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INTRODUCTION

During the first phases of the COVID-19 pandemic, Sweden received international attention for choosing less strict countermeasures compared to many other countries including neighbouring countries such as Norway and Denmark (1) and for relying on voluntary compliance (2). The relative lack of restrictions such as lockdowns or closures of non-essential physical venues illustrates

the use of a mitigation strategy with social distancing to protect the elderly and the functioning of the healthcare services, rather than a suppression strategy (3). Within Sweden, one of the most debated aspects of the pandemic response has been *COVID-19 testing* and the time it took to increase testing capacity. In June 2021, when presenting its review of the government's actions, the Swedish parliament's constitutional committee concluded that the government had failed in six cases related to the COVID-19 pandemic. One of these cases was COVID-19 testing, which, according to the committee, started too late and suffered from an unclear division of responsibilities. In particular, the unclear division of responsibilities concerned the state (the government and the government authorities) vis-à-vis the self-governing regions responsible for funding and providing healthcare. This is investigated further in the present article.

The Swedish COVID-19 strategy has been the subject of a few published research studies, so far where some aspects of COVID-19 testing are described (4, 5), and the low level of testing capacity has been linked, for example, to an underestimation of infected persons (6, 7), and mortality in long-term care facilities (3). In international research on COVID-19 testing, mass testing has been suggested as a cornerstone for handling the pandemic (8) and a powerful means to supress the spread instead of, or in addition to, lockdown (9). Among national politicians in Sweden, opinions have differed regarding whether Sweden has tested too little or much in relation to its population size. As shown in **Figure 1**, in 2020, Sweden tested for COVID-19 far less than Denmark, but roughly in line with Norway and Finland. During the period between July 20 and October 25, Sweden tested fewer people per 100,000 inhabitants than Finland and Norway. For most of 2020, Sweden tested less than Norway. However, looking at the positivity rates, Sweden stood out from mid-March with a much higher number of new confirmed cases per test than other Nordic countries, pointing to a more extensive spread [cp. (10)], and thus less testing in relation to the number of cases (**Figure 2**). The number of tests per week in Sweden during 2020 is presented in **Figure 3**, together with some of the most important COVID-19 testing strategy decisions (including some international references).

In this article, the development of and the debate surrounding COVID-19 testing in Sweden during 2020 is described in detail, with a particular focus on the coordination between national and regional actors. This article thus illustrates the problems associated with multi-level governance in healthcare during a crisis and also contributes to understanding one of the most debated aspects of the Swedish pandemic response.

METHODS

Design

A qualitative case study allowing for in-depth, detailed examination of the particular case of COVID-19 testing in Sweden during 2020 was carried out.

Data Sources

The sources of data for the in-depth description were publicly available documents (although some not available online) and press material from 2020. From the government, all press releases

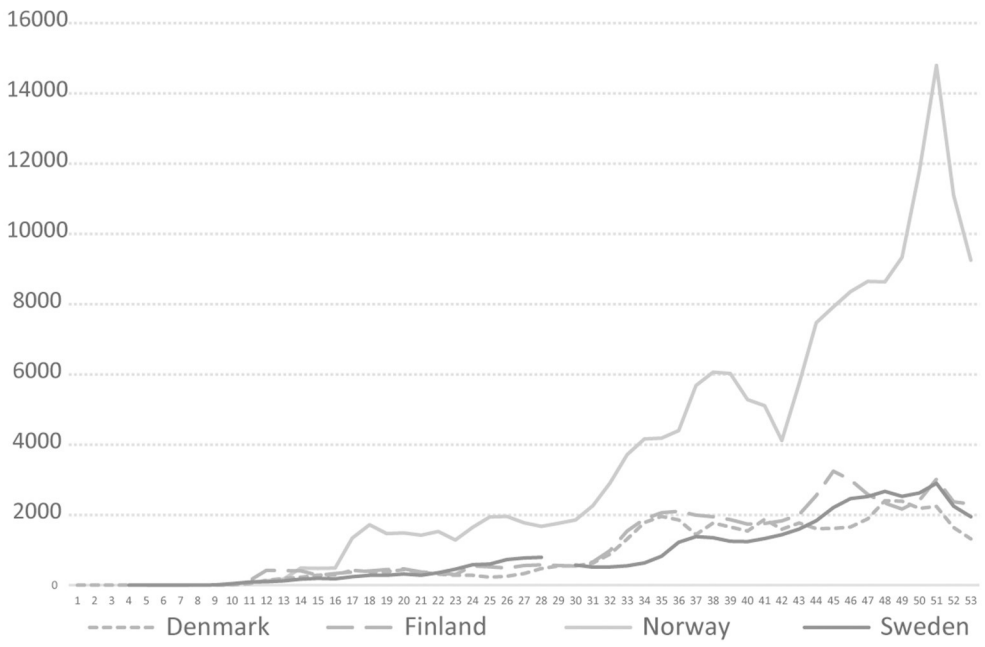

FIGURE 1 | COVID-19 testing rate per 100,000 in four Nordic countries during 2020, Weeks 1–53, 2020. https://www.ecdc.europa.eu/en/publications-data/COVID-19-testing.

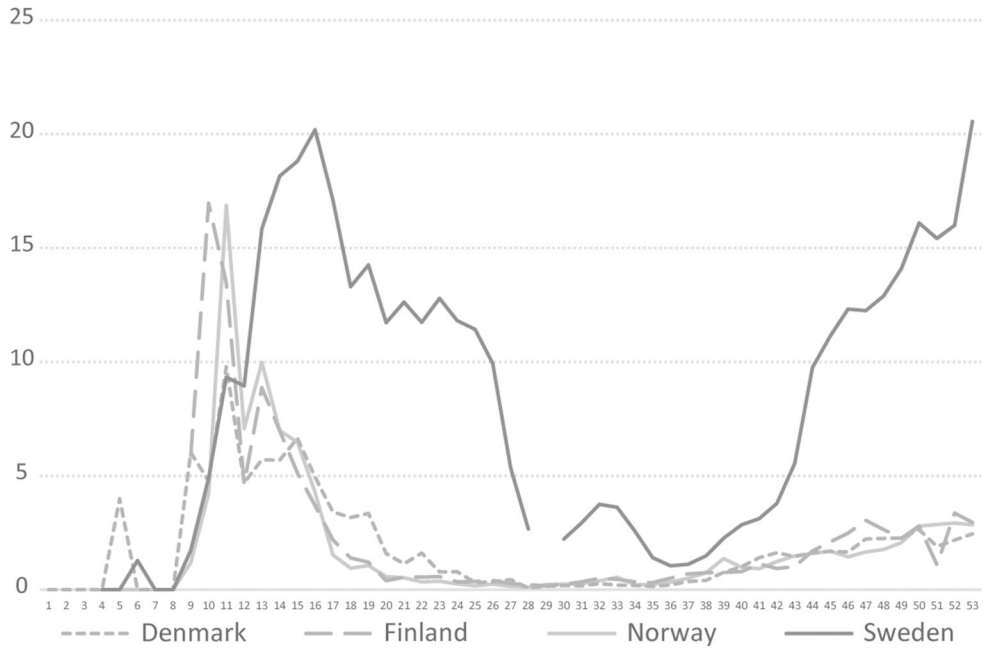

FIGURE 2 | COVID-19 testing positivity rate in four Nordic countries during 2020, Weeks 1–53, 2020. https://www.ecdc.europa.eu/en/publications-data/COVID-19-testing.

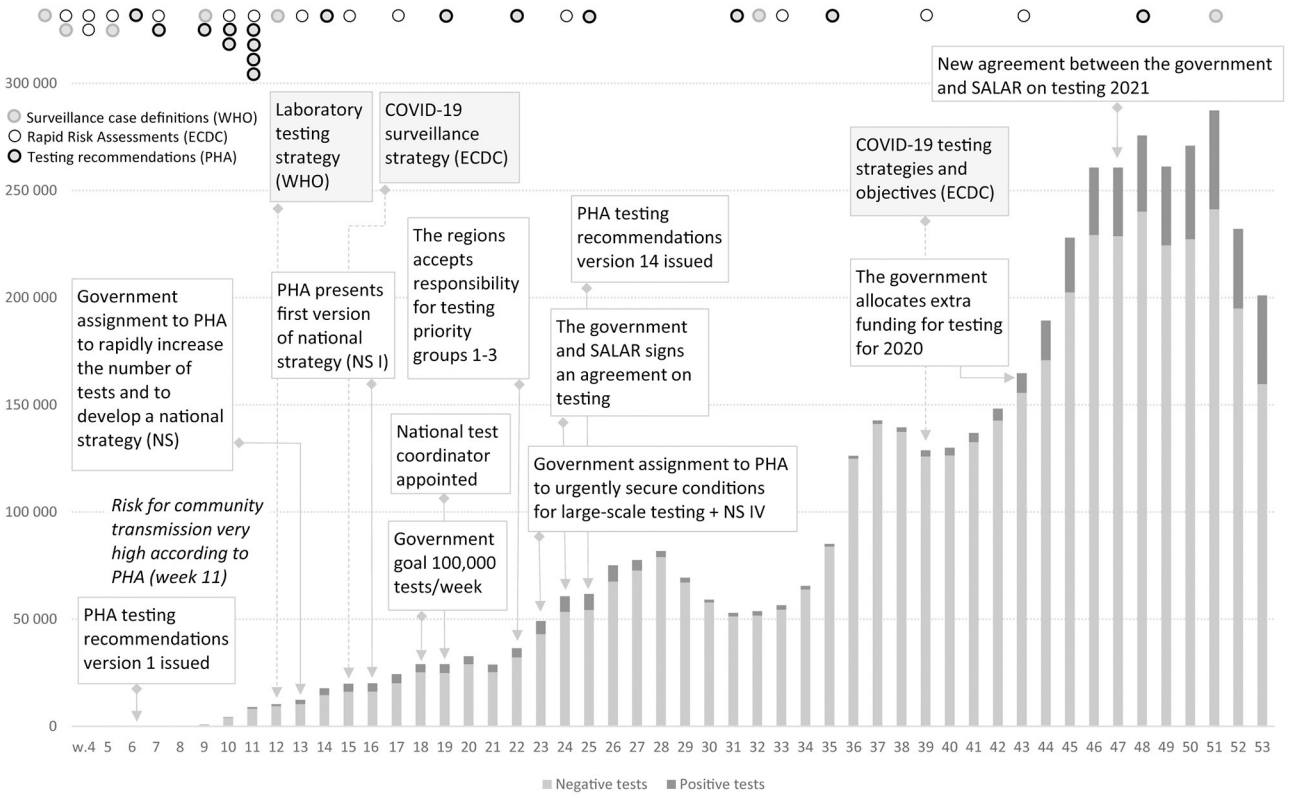

FIGURE 3 | Positive and negative COVID-19 tests in Sweden during 2020, Weeks 1–53, 2020. There are minor variations in the weekly reports on the number of tests taken and number of detected cases. https://www.folkhalsomyndigheten.se/folkhalsorapportering-statistik/statistik-a-o/sjukdomsstatistik/covid-19-veckorapporter/.

from the Ministry of Health and Social Affairs with bearing on COVID-19 testing were analysed, as well as the government's assignments to the Public Health Agency of Sweden (PHA). From the PHA, all of their press releases on COVID-19 testing were analysed, as well as the 17 versions of the COVID-19 testing indications and the four versions of the National Strategy for COVID-19 testing. The press releases from the Swedish Association of Local Authorities and Regions (SALAR) were also analysed. In addition, the parliament's constitutional committee examination of the government's handling of the COVID-19 pandemic was used as a source (11), along with weekly statistical reports on COVID-19 from the PHA.

A sample of Swedish national newspapers (*Dagens Nyheter*, *Svenska Dagbladet*, *Aftonbladet,* and *Dagens Medicin*) were also analysed based on a search in Retriever Research for "covid test* AND (Lena Hallengren (Minister of Health and Social Affairs) OR Harriet Wallberg (National Coordinator for COVID-19 testing) OR Ulf Kristersson (Opposition leader) OR Anders Tegnell (State Epidemiologist) OR Karin Tegmark Wisell (Head of the Microbiology division at the PHA))".

Analysis

The analysis was carried out as a qualitative document analysis (12) with a chronological presentation aiming to describe in detail the process of establishing COVID-19 testing in Sweden. The analysis focussed on finding and describing the main events and arguments, but also on covering different perspectives and actors in relation to the main events. Throughout the chronological description, there is a presentation of the number of COVID-19 tests performed in the country and the number of confirmed cases of COVID-19. There are also some references to published recommendations and/or strategies with bearing on COVID-19 testing by the World Health Organization (WHO) and the European Centre for Disease Prevention and Control (ECDC, an EU agency aimed at strengthening Europe's defences against infectious diseases).

Context

The analysis took into consideration the specific context of the Swedish multi-level healthcare system and below some crucial contextual information is presented.

A Multi-Level System

In Sweden, the responsibility for healthcare is divided between three governing levels: state, regions and municipalities. The *state* is responsible for overall healthcare policy and laws. The *21 regions* are the key actors responsible for funding healthcare (about 80% comes from local taxes and patient fees and 20% from state grants) and for providing healthcare to their residents. The Health and Medical Services Act (2017:30) states that the regions shall provide good healthcare to their residents and work towards their good health (Ch. 8, §1: 2017:30). The *291 municipalities* are responsible for certain types of healthcare related to the long-term care of elderly people and people with disabilities. All of the regions and municipalities are members of the Swedish Association of Local Authorities and Regions (SALAR), which is an employers' organisation that also advocates for local/regional government. SALAR represents the regions and municipalities in discussions and negotiations with the Ministry of Health and Social Affairs. In practise, Swedish healthcare is highly decentralised, and the regions are self-governing with politically elected assemblies, as set down in the Swedish constitution (1974:152), and overall, it can be described as an arrangement with 21 regional health systems.

The Government and Government Agencies

The government rules the country by enforcing the parliament's decisions and taking initiatives to develop new laws and amendments to laws. To assist in this work, the government has Government Offices and about *220 government agencies*. Each year the government gives instructions to the government agencies (through a regulation letter) on how to work and how much money they can use. However, the government cannot control how the agencies interpret the laws, and, importantly, in Sweden, the ministers are not allowed to issue orders personally to agencies in their portfolio or to interfere with their day-to-day work (i.e., ban on ministerial rule). Of specific importance for COVID-19 testing has been the *Public Health Agency of Sweden* (PHA), but also to some extent the Swedish Civil Contingencies Agency (MSB), which is responsible for issues concerning civil protection, public safety, emergency management and civil defence, and the National Board of Health and Welfare (NBHW), which the government gave the task of being a national purchaser of, for example, material for COVID-19 tests, and if necessary, redistributing material between the regions (13).

Public Health Agency of Sweden

The PHA is an agency that has a national responsibility for public health issues, where provision of knowledge and guidelines is crucial. Their mission is to promote good and equal health, prevent illness and injuries and work for effective communicable disease prevention and control, as well as protecting the public from different types of health threats (14). The PHA has the overall national responsibility for protection of the public against communicable diseases, and from 2014, it also coordinates communicable disease control at the national level.

The agency is led by a director general, and the management group includes the heads of six different divisions and the director general's office (15). At the agency, there is a State epidemiologist and a deputy state epidemiologist, who are tasked coordinating the monitoring and analyses of the development of communicable diseases nationally and internationally and the protection against these diseases. The agency issues regulations (binding clarifications of the law); recommendations (non-binding but building on evidence or best current expert knowledge in areas that may change rapidly due to new or unknown factors); and guidance to healthcare staff to ensure effective disease control. In the case of COVID-19 testing, an important document has been the testing indications (17 versions during 2020, see **Supplementary Table 1** for summary)–that is, the recommendations about whom to test for COVID-19 infection.

Another important task of the PHA is carrying out microbiological laboratory analyses and providing expert

support in dealing with suspected or established outbreaks of communicable diseases, as well as maintaining the laboratory preparedness needed for effective communicable disease control (14). The agency provides support for quality and methods development at laboratories that carry out analyses of importance for the country's communicable disease control (2021:248, §19). The PHA also provides the government with expert knowledge and information within its portfolio (2021:248, §3). In its *pandemic preparedness plan*, the overarching goals for pandemic responses are to minimise mortality and morbidity in the population and to minimise other negative consequences for individuals and society. According to the PHA, this requires *medical action* (antiviral treatment and vaccinations), *non-medical action* (e.g., social distancing) and *communication*. Broad testing is not mentioned in the pandemic preparedness plan, but it is mentioned that it is the PHA's task to monitor the spread of a virus through laboratory testing. Based on the World Health Organisation's (WHO) guidance for Pandemic Influenza Preparedness and Response (16), the PHA prescribes actions during the activation phase (detailed monitoring of every case and contact tracing), the pandemic phase (where national monitoring data is used to estimate the spread) and post-peak phase (responses can be phased out). There are also two specific preparedness plans for communication and access to medicines during a pandemic (17, 18).

Communicable Disease Control

A specific law regulates *communicable disease control* (2004:168), the first chapter of which specifies responsibilities. The PHA is responsible for coordination of communicable disease control at the national level and should take the initiatives necessary to maintain effective control (Ch. 1, §7). Furthermore, each region is responsible for taking necessary communicable disease control measures within its area (§8). The roles and responsibilities of the different authorities during a pandemic specifically is further specified in the pandemic preparedness plan mentioned above. Each region must have an Infection Control Practitioner, a physician responsible for communicable disease control (§9). These have an overall responsibility for the communicable disease control in the region and plan, organise and lead the necessary work (Ch. 6, §1). The law specifies a number of specific tasks [Chap. 6, §2, 1–8)] such as providing information to the public, giving advice to risk groups, supporting healthcare staff and ensuring that caregivers take the necessary measures to prevent the spread of infection.

Furthermore, clinical microbiological laboratories perform analyses on behalf of the healthcare services. There are usually 24 laboratories (the number was extended during the pandemic by the contracting of laboratories that do not perform that kind of analyses during normal conditions), of which the majority operate as part of the regions. Two of the 24 laboratories are private actors contracted by some of the regions (19). All of the 24 regular laboratories are part of a national network initiated by the PHA (together with SALAR) in 2014 and established in 2016. At the national level, there is also a forum for emergency diagnostics.

Crisis Management

In Sweden, crisis management is built on collaboration between different agencies, regions and municipalities, as well as between businesses and civil society (20). No specific legislation for overall crisis management is activated, instead the ordinary management structure is kept. Three principles are important: (i) the *responsibility principle*: the one responsible for a service/function under normal conditions is also responsible during a crisis situation; (ii) the *likeness principle*: during a crisis, a service or a function should operate as similarly as possible to normal condition; and (iii) the *proximity principle*: a crisis should be handled where it occurs and by those who are most affected and responsible. It is thus primarily the affected municipality or region that lead an effort. In line with this, there is a specific law that regulates what preparations need to be ensured at the local level (2006:544). Only if the local resources are not enough will it be relevant with government funding (11). Regarding healthcare, the Health and Medical Services Act (2017:30) stipulates that the regions are responsible for planning healthcare so that emergency medical preparedness is maintained (Chap. 7, §2).

RESULTS

January–February

On **January 31**, Sweden got its first *confirmed case* of COVID-19 (21). At the request of the PHA, the government decided to include 2019-nCoV in the Communicable Diseases Act by **February 1**, meaning that particular infection control measures could be taken (such as isolation) and that testing became mandatory if assessed as necessary by a physician; contact tracing was also mandated (22). On **February 7**, the PHA issued its first version of recommendations for the conditions under which testing for COVID-19 should take place (at this point labelled "instructions"). Individuals that had been to certain parts of China (or that had been in close contact with an infected person) and that presented with acute illness with fever, cough or dyspnoea, or needed hospital care should be tested (23). While waiting for the test results, patients in need of care would be isolated at infection clinics and people staying at home given information on how to avoid spreading the virus (24). Version 1–6 of the PHA testing recommendations were fairly similar but contained updates on which countries and areas were included in the criteria for testing (2020-02-07; 2020-02-12; 2020-02-24; 2020-02-27; 2020-03-02; 2020-03-06). As a point of reference, in their first Rapid risk assessment (January 17), the ECDC stated that they had developed a guidance document addressing questions on how to identify suspected cases and when to initiate testing (25). Starting on January 11, the WHO continuously updated case definitions for surveillance, i.e., who should be investigated and tested. At the end of January, the WHO's case definition was similar to the first Swedish one (26).

On **February 13**, about 150 COVID-19 tests had been analysed by the PHA's own clinical microbiology laboratory, which had had diagnostics in place since mid-January. Although the PHA still assessed the risk for spread of the virus as low within Sweden, they had engaged in dialogue with laboratories to increase the capacity for *analysing* COVID-19 tests in the

regions. At that point, eight laboratories in Sweden, except for the PHA's own laboratories, were about to start analysing COVID-19 tests (27). On **February 26**, about 300 tests had been analysed in Sweden, with two *confirmed cases*, and the PHA still assessed the risk for community transmission as low (28). Two days earlier, on **February 24**, the PHA had recommended that people who had been in some parts of China, Iraq, South Korea and Italy should be aware of symptoms and in such cases should call the national 1177 telephone advise service for an assessment (29). During February and at the beginning of March, there were media reports about people being denied a COVID-19 test although fulfilling the criteria (30, 31), but also about the introduction of COVID-19 testing carried out by specially equipped ambulances in Stockholm (32).

March

The risk for community transmission within Sweden was updated to the level "moderate" by the PHA on **March 2**, when about 1,000 tests had been analysed, with *14 confirmed cases* (33). The day after, **March 3**, the PHA recommended that people who had visited any of nine regions in Italy and developed symptoms within 14 days, should be tested (this was extended to the Austrian state of Tyrol, including Innsbruck, on March 9) (34). On **March 4**, the PHA recommended that the laboratories analysing COVID-19 tests should investigate the possibility of also routinely looking for COVID-19 in tests from patients with respiratory symptoms without known cause to find undetected cases. Tests from the ordinary sentinel system surveying influenza across the country were also from this point to be analysed by the PHA for COVID-19 (35). This was in line with recommendations from the ECDC on March 2, also presenting five scenarios with options for response. It was acknowledged that different countries may be in different scenarios and that testing approaches needed to be adapted to the situation at local and national levels. However, the ECDC anticipated a rapid increase in the demand for testing and concluded that "countries should consider the roll-out of primary diagnostic testing capacity to local clinical and diagnostic laboratories"(36).

In Sweden, to strengthen COVID-19 preparedness, the government announced on **March 5** that the PHA and the NBHW could use "the resources they needed" and the PHA was assigned to develop their coordination and information efforts towards relevant authorities and actors (37). On **March 10**, the PHA upgraded the risk for community transmission to very high and urged everyone with symptoms of respiratory infection to refrain from social contact (38). The week before, *211 new cases* had been detected (39), and on **March 11** the PHA petitioned the government to limit public gatherings to a maximum of 500 people [the same day as WHO declared COVID-19 as a pandemic (40, 41)]. On **March 13**, Swedish media reported that there was a national shortage of test kits and reagents (42). The same day, the PHA announced that the work of decelerating the spread of COVID-19 in society was entering a new phase and that the new focus was on delaying the spread of infection while simultaneously protecting the oldest and the most fragile against the virus. Thus, the strategy of finding all cases through testing people with symptoms that had been in certain areas abroad was no longer deemed the most effective.

In line with the ECDC recommending that testing approaches should prioritise vulnerable populations, protection of social and healthcare institutions, including staff (if testing capacity was overwhelmed by a large number of tests in countries experiencing localised outbreaks or widespread sustained transmission) (43), the PHA concluded that health services and clinical microbiological laboratories needed to redirect their resources for testing and analysis to where they were needed the most (44), and version 9 of the PHA testing recommendations (now labelled "indications") were issued (45). The PHA recommended COVID-19 testing for people in need of inpatient hospital care who had become acutely ill with fever or respiratory symptoms, without known cause, and to healthcare and social care staff working with the elderly, falling ill with acute fever and respiratory symptoms. The purpose was to prevent the virus from spreading within healthcare and social care services. The PHA also announced that there was "no specific medical treatment to COVID-19" and "that almost everyone gets a mild illness and recovers after a period of self-care at home." The agency therefore saw no *medical* reasons to test everyone falling ill with symptoms such as cough, runny nose, fever or anything else that may indicate COVID-19, but could also be another infection. Thus, in version 9 of the PHA testing indications, identifying cases of COVID-19 in society was declared a non-priority (although regions could do this if the regional Infection Control Practitioner assessed it to be relevant from a local epidemiological perspective), which was, however, quickly changed (the day after) to only emphasising which groups should be prioritised (version 10–13). The state epidemiologist said it was of the utmost importance that people were responsible and stayed at home if they were not feeling well and, as a precaution, two days after recovery. The PHA furthermore announced that they would monitor the epidemic through other methods than through extensive testing (44). In line with this, on **March 26**, the PHA announced that they were measuring the occurrence of COVID-19 in the population among randomly selected individuals in Stockholm (46) (about 2.5% had an ongoing infection, see **Table 1**). At this point, a number of researchers criticised the PHA's recommendations for testing in an open letter to the government and suggested much more extensive testing to be more certain about the spread and to be able to isolate only the individuals who were infected (47). About 2 weeks earlier, on **March 16**, the head of the WHO announced that "Our key message is: test, test, test" and that "social distancing measures and handwashing will not alone extinguish the epidemic"(48). **March 18**, the EU recommendations for testing strategies suggested that "timely and accurate laboratory testing" was "an essential part of the management of COVID-19". Among other things, it was mentioned that testing helped detecting asymptomatic persons that could spread the virus if not being isolated (49). Similarly, on **March 21**, the WHO's Laboratory testing strategy recommendations recommended countries to scale-up and prepare for a testing surge to, for instance, reduce transmission (although noting that it might be necessary to prioritise who got tested) (50).

TABLE 1 | Results from the PHA's population tests to monitor the spread of COVID-19 during 2020.

Area	Test dates	Ongoing infection	Sample size
Stockholm	March 26–April 3	2.5%	$n = 738$
Sweden	April 21–24 (a)	0.9%	$n = 2,571$
Stockholm	April 21–24 - subsample of (a)	2.3%	$n = 679$
Sweden	May 25–28 (b)	0.3%	$n = 2,957$
Stockholm	May 25–28 - subsample of (b)	0.7%	$n = 761$
Sweden	August 24–28	No one	$n = 2,518$
Sweden	September 21–25	No one	$n = 2,461$
Sweden	November 30–December 4 (c)	0.7%	$n = 2,983$
Stockholm	November 30–December 4 - subsample of (c)	1.0%	$n = 790$

Source: PHA.

As a response to the spread of COVID-19, the Swedish government decided on an amended budget on **March 19**, in which public health and healthcare received an additional 1.5 billion SEK to cover increased costs, such as higher costs for personnel, laboratory analyses and infection control measures (testing and contact tracing were not explicitly mentioned, however) (51). The money could be claimed afterwards and was to be paid out on November 30. In addition, on **the last day of March**, the government assigned the PHA to *rapidly increase the number of COVID-19 tests* (primarily for ongoing infection and later on for antibodies) and to develop a national strategy (NS) for enhancing the capacity to test people for COVID-19 (52). The PHA was tasked with coordinating the work at the national level to expand testing and lead the work of coordinating regions, municipalities, and other actors needed to expand testing while maintaining quality assurance and prioritising resources to healthcare and social care (i.e., making sure that enhanced testing did not crowd out necessary testing of patients and staff) (53). This was to protect the most vulnerable groups in society from the virus. However, another main purpose of the strategy was to reduce negative societal effects from a large loss of staff in healthcare and social care and in other functions of importance for society (52) such as the police and emergency services (54). It was pointed out that necessary staff were probably staying home, although they did not have to if they could be tested. The Minister of Health and Social Affairs, however, pointed out that "it will not be the case that everyone will be able to take a COVID-19 test" (55). In connexion with the government commission, the PHA summoned a number of relevant actors, such as universities and private companies, to meeting on April 1 to ensure diagnostic capacity while maintaining test quality and patient safety (56).

April–May

On **April 1**, the government decided on another amended budget, in which 1 billion SEK was earmarked for COVID-19 testing (disposed of by the PHA) to reduce the spread of the infection and to avoid unnecessary loss of staff in healthcare and other important societal sectors (57). Up to that point, *3,917 cases of COVID-19* had been confirmed in Sweden (58), and the limit for public gatherings had been lowered to 50 people (59). On **April 10**, the leader of the biggest opposition party criticised the slow pace in building testing capacity in Sweden [about 19,900 tests were taken in Sweden during the period April 6–12 (60), see **Figure 1**] and argued that the government had to take a clearer leading role, agreeing they in part did so with the assignment to the PHA to develop a national testing strategy (61). At that point, the ECDC concluded that with no indication at EU/EEA level that the peak of the epidemic had been reached, a strong focus should remain on comprehensive testing and surveillance strategies (including contact tracing). If testing capacities were sufficient, all patients meeting the EU case definition should be tested (62).

The PHA presented the first version of the national strategy (NS I) on **April 17** (which was updated April 30 and May 5). By the end of that week, there were *14,577 cases of COVID-19* in Sweden, with about 94,600 tests (63) since the outbreak, and the recommendation from the PHA was that people should stay at home if experiencing symptoms that could indicate COVID-19. It was pointed out by the PHA that NS I was a support in prioritising what groups to test, and the "target image" of NS I was presented as "a nationally secured, sustainable, and robust capacity for testing and diagnostics of COVID-19 within healthcare, eldercare, and institutional care". The aim was to minimise the spread of the virus within those vulnerable groups. Thereafter, the target image was increased national capacity for testing and analysis of other groups. To achieve this, the PHA estimated that, as a first step, the analytic capacity had to be increased to 150,000 tests per week. It was also pointed out that before the capacity could be expanded, it was necessary to prioritise not crowding out those in greatest need. Priority groups were presented (1–4), as shown in **Table 2**. About a week later, on April 23, the ECDC concluded that one of the public health objectives was increased testing capacity and that large-scale testing (to detect cases and monitor the spread of the virus combined with contact tracing and isolation measures) was a pivotal criterion of the Joint European Roadmap towards lifting COVID-19 containment measures (64).

In NS I, the PHA also suggested how to handle the testing in the regions by presenting different flows for the four priority groups (see **Supplementary Table 2** for more details) and pointed out that increased testing required that actors that were normally not contracted by the regions to analyse tests

TABLE 2 | Priority groups presented in the first national strategy for COVID-19 testing.

Group	Description
1	Patients falling ill with acute infections in need of inpatient care, inpatients at hospitals, individuals belonging to any risk group and residents in care and in institutions.
2	Healthcare and social care staff
3	Individuals having other functions of importance for society; the MSB on May 19 published a list of which functions were classified as important for society during the pandemic (after being advised against publishing it by the PHA because it was not clear enough) (11, 65), as well as a support for employers to identify relevant staff members (66).
4	Other relevant parts of society.

Source: Nationell strategi för utökad provtagning och laboratorieanalys av covid-19 (NS IV). Since March 12, the testing indications included prioritised groups.

had to assist. A forum for coordination of such actors was also established.

The national strategy was updated on **April 30** to also include serologic testing (i.e., antibody testing; NS II). The PHA meant that, for individuals belonging to a risk group, it could be valuable to know whether they had had COVID-19 and thus be able to lead a more normal life, but staff in healthcare and social care were prioritised (67). On **May 1**, the Minister of Health and Social Affairs said that the goal was to reach 100,000 tests per week by the middle of May (it was reached during the first week of September). This primarily concerned tests for ongoing infection, but the Minister also noted that it was important to build capacity for serologic testing (although there were still problems to solve to ensure testing quality) (68). The Director General of the PHA said that there was now enough laboratory capacity across the country to analyse that number of tests and the Minister emphasised that "the regions had to increase the pace of testing" because fewer tests were performed than the analysis capacity throughout the country allowed. The Minister of Health and Social Affairs also emphasised that the government had been clear with the regions regarding the costs linked to COVID-19 and that they could claim compensation retroactively (69, 70). Between April 27 and May 3, 28,997 individual tests were taken with 3,728 new confirmed cases (13% positive) (71), although the nation-wide laboratory capacity was for about 130,000 analyses during the same period (72).

On **May 8**, the PHA published version 12 of the testing indications: to test those falling ill with symptoms described for COVID-19 within priority groups 1 and 2. It was stated that priority groups 3 and 4 would be included at a later stage and that the work of defining who belonged to priority group 3 (individuals with important functions in society) was under way. It was, however, noted that regional and local adaptations could be made (73). Also, on **May 8**, the government presented the appointment of a test coordinator, who would be placed at the PHA to coordinate the dialogue with the regions regarding large-scale testing for COVID-19 and to increase the pace of testing (74). The chair of SALAR's healthcare delegation commented that several of the regions had worked extensively the past weeks to "gear up to large-scale testing." The chair pointed to the necessity of developing the proper infrastructure and logistics to increase testing, such as securing transports of taken tests and access to test material (75). **In the middle of May**, the test coordinator's view was that some regions had come far with building testing capacity while others were still only in the beginning stages, and furthermore, the coordinator said that the focus onwards would be to expand testing for priority groups 1–3 (76). However, the test coordinator could not say when testing of priority groups 3 (or 4) would begin or when the 100,000-target would be reached (77).

On **May 19**, the Minister of Health and Social Affairs announced that it would become possible for those ill, but not in need of hospital care (e.g., seeking care at a health centre or other open healthcare facility), to take a COVID-19 test (thus becoming priority group 1) (78). The PHA, however, pointed out that this did not mean that everyone seeking care would be tested, but only if a physician made an assessment that it was relevant from a medical point of view (79). The government also confirmed that it would cover the costs for priority group 3–that is, individuals having functions of importance for society [list on those groups published the previous day (11)]. The national test coordinator explained that there had been a lack of clarity, which had delayed testing, about who belonged to that group and who would fund the testing but said that "Now there are no excuses"(79). About a week later, on **May 26** (in a dialogue between the PHA, the regions and SALAR), the regions made a decision to take responsibility for testing priority groups 1–3 (although this was not properly implemented). This decision was based on the government's repeated assurances that it would fund the testing and that the regions could use private providers and the analysis capacity secured by the PHA at the national level. From this point on, SALAR became more involved in COVID-19 testing, announcing that the regions were quickly building the capacity and competence to secure testing for priority groups 1–3, but that that the responsibility to test priority group 4–that is, other relevant parts of society–was still not clear (80).

The next day, **May 27**, the PHA issued new recommendations for testing (version 13) to include onset of symptoms described for COVID-19 in priority groups 1–3. Priority group 4 was to be included at a later stage, although allowing for regional or local adaptations (81). The same day, the prime minster claimed that the regions had the responsibility for testing all four priority groups, while SALAR replied that the regions and SALAR had not been asked to take this responsibility, and in this case, the purpose and financial compensation had to be discussed (80). The prime minister's press secretary, however, claimed that because the regions have the responsibility for communicable disease control, they have a large role in all testing and contact tracing because but that they could involve other actors (11). On **May 28**, the chair of SALAR's healthcare delegation described the past weeks as "confusing" and explained that the health service works from the point of view of *medical need*, which is why its focus had been on testing patients and staff (priority groups 1 and 2). She further explained that it was unclear for the regions how to handle the other groups and what the purpose of testing these groups was: to

get a better understanding of the spread of the virus or to know whether people can go to work or not? (The latter is not a task for the health system to handle according to SALAR) (82).

At the end of May, "failed testing" was intensely discussed in the media, and the opposition leader, for instance, blamed the government for the failed testing capacity. He meant that the government had not put its foot down and been clear enough about the responsibilities, funding and timeline (83). When pressured to answer why the Swedish COVID-19 testing had failed, the Minister of Health and Social Affairs answered: "There may by 21 different answers to the question why we have not scaled up our testing capacity. There is not one answer" (84). In line with this, the national test coordinator said that the decentralised system was one reason why the scale-up of testing had been slow, and she also said there had been shortcomings in the regional logistics, for example in the digital systems for referrals and test answers (82). A few days earlier, the Minister of Health and Social Affairs said in a radio interview that "potentially naively" she had thought that when there was analytic capacity for 100,000 tests nationally, and the government had announced it would not be any additional cost for the regions, that the regions would be eager to do the testing rather than finding it hard to build testing capacity (85).

On **May 29**, the PHA published a support document and announced that it was "desirable and justified" to engage in generous testing and contact tracing among elderly and staff in eldercare to discover and prevent the spread of COVID-19 (revised version June 17) (86). In the **last week of May**, about 36,500 individuals were tested and, in total, there had been *38,897 confirmed cases* since the beginning of the outbreak (87).

June

During the first week of June, nation-wide laboratory capacity was about 140,000 analyses per week, but only about 49,000 tests were analysed (72). On **June 3**, it was announced that the national test coordinator's assignment, which had included to find the bottlenecks, was over (88). On **June 4**, the government proclaimed that it wanted to "see a sharp increase in testing and contact tracing." It therefore gave the PHA a third assignment, to urgently secure the conditions for *large-scale* COVID-19 testing in collaboration with the regions and the county administrations and allocated 5.9 billion SEK to this enterprise (of which 1 billion was earmarked for contact tracing). For serologic testing, the PHA was supposed to provide a concrete action plan and timeline to urgently build large-scale testing capacity. For ongoing infection (PCR-testing), the PHA was supposed to assist the regions and county administrations with concrete advice for how the capacity could be increased to test *everyone with symptoms*, irrespective of priority group, and to do contact tracing (89).

To specify the tasks and funding procedure, an agreement (a common collaborative form between the government and SALAR) was signed on **June 11**, according to which the government agreed to take on the costs for testing, while the regions agreed to perform the tests in accordance with the recommendations from the PHA (90). It was stated that increased testing was an important aspect for trying to stop the spread of the virus, but that the variation in spread throughout the country required flexibility and regional adaptation regarding how testing was carried out. This was in line with NS IV (which was released by the PHA the previous day, June 10), in which the PHA pointed out that the purpose of testing for ongoing infection varied depending on the pandemic phase and that the regions may be in different pandemic phases at a certain point in time and may thus appropriately have different testing capacities (72). New testing recommendations, version 14, applied from **June 17**: to test individuals presenting symptoms described for COVID-19 (91). This was in line with the ECDC suggesting that an expanded testing strategy aiming for comprehensive testing of all individuals displaying symptoms compatible with COVID-19 was essential. The ECDC recommended that testing efforts were *maximised* and concluded that the obstacles hindering such an approach was now mostly overcome (92). The same overarching message was presented in the following rapid risk assessments (August 10, 2020; September 24, 2020; October 23, 2020). Between June 14 and 20, 59,861 individual tests were analysed with 7,229 new confirmed cases (*52,189 cases in total*) (93).

July–October

During July and August, the spread of the virus was rather low, and for the last week of July, the number of new cases and people in intensive care with COVID-19 was at the same level as at the end of March (94). On **July 21**, the PHA published guidance on how to assess who is immune to COVID-19 and what that meant for how to have close contact with others (95), and on **July 23**, they provided guidance on contact tracing (96). During **the last week of August**, 85,060 tests were analysed (1.6% positive) and *83,986 cases had been confirmed in total* (97). During that time, there was criticism of the lack of contact tracing in Region Stockholm (98) and a questioning of whether serologic testing had any effect on reducing the spread of the virus (99). On **August 31**, about 10 days after the schools started after summer holiday, the PHA presented new guidance to the regions on testing children and youth for COVID-19. The PHA recommended that children from pre-school to gymnasium be tested if having COVID-19 symptoms, so they could go back to school as soon as possible (100).

On **September 1**, the PHA presented their view on what efforts were needed to reduce the spread of the infection during the year to come. The PHA highlighted staying home when ill, keeping distance and good hand hygiene, but also mentioned *generous testing* and contact tracing (101). By that time, the PHA recommended that people without symptoms, but who had had close contact with an infected person, should avoid close contact with other people. On **September 21**, the government announced that as part of the state budget of 2021, 2 billion SEK would be allocated to continued testing and contact tracing in the regions (102). In the **last week of September**, 128,852 tests were analysed (2.4% positive) and *the total number of confirmed cases was 91,911*. About 2 weeks earlier, the ECDC released a document outlining strategies and objectives for sustainable COVID-19 testing for different epidemiological situations. A number of different objectives were described, e.g., to control

transmission (testing all individuals with COVID-19-compatible symptoms as soon as possible after symptom onset) and to mitigate the impact of COVID-19 in healthcare and social-care settings. It was emphasised that "testing strategies should be flexible and rapidly adaptable to change, depending on the local epidemiology, transmission, population dynamics and resources" (103).

From **October 1**, there were new recommendations from the PHA that people sharing a house or living accommodations with an infected person should also get "behavioural instructions," for example not to go to work (after being contacted by a contact tracer and given more information) and to get a test after 5 days even if not showing any symptoms (104). In an additional revised budget on **October 30**, the government announced an additional 3 billion SEK during 2020 to meet the need for large-scale testing for the remainder of the year (105). During the **last week of October**, 189,301 tests were analysed (9.7% positive) with about 18,500 new confirmed cases and *133,084 confirmed cases in total*. The PHA concluded that there was now an extensive community transmission of COVID-19 (106). About 2 weeks earlier, the PHA had been given the mandate to decide, after consulting the regional Infection Control Practitioner, on local recommendations for restrictions in activities such as travel, restaurant and gym visits and visits to elder care facilities (107). The Minister of Health and Social Affairs maintained her critique from the spring that the regions should have built up the testing capacity faster, which would probably have had positive benefits now (108).

November–December

On **November 2**, it was reported that Region Stockholm had to pause the system with home testing due to a rapidly increasing queue (16,000 tests) caused by an increasing spread of the virus (109). The week before, there was an increase by 102% in the number of confirmed cases in the country (106). The Minister of Health and Social Affairs indicated that the stop of home-tests in Stockholm was problematic because the state had allocated multi-billion sums to increase testing capacity in the regions (110). The leader of the biggest opposition party said that the Minister of Health and Social Affairs "declared a war against the regions saying that they were responsible for [the failed] testing during the spring," and that "it was clearly a state responsibility" (110).

On **November 12**, 7 regions reported that they were operating at their maximum capacity for testing, and 16 regions were experiencing increased strain on the system. The Minister of Health and Social Affairs therefore summoned the PHA, the regions and the NBHW to a meeting about testing capacity (where laboratory capacity was identified as a bottleneck) (111). The Minister indicated that large-scale testing was important to combat the spread of the virus and that it was a cause for concern that the regions could not test as much as needed (112). The Section Head of the Division of Health Care at SALAR called the situation "unfortunate," but also said it was "a snapshot" and that the regions were working hard to increase COVID-19 testing capacity (113). Representatives of some of the regions noted that they had built the testing capacity based on the PHA's predictions for the autumn–which was cluster spread–and that they would have prepared differently if they had known there would be a second wave of infection (114). Again, leaders of the opposition parties criticised the government's handling of COVID-19 testing and demanded that the government present a plan for increasing testing capacity (115). In the week of **November 9–15**, 254,295 tests were analysed (12.9% positive) with about 31,400 new cases, an increase with 24% from the week before (116).

On **November 18**, the media reported that about half of the regions were operating at their maximum capacity for testing, due to (among other causes) lack of testing material, staff and laboratory capacity. A few regions bought analysis capacity from abroad and thought the national coordination of laboratory capacity was insufficient, and some regions indicated that the PHA had failed in securing access to national analysis capacity (which they had agreed to deliver in the agreement from June 11). The PHA replied that they would order more tests from the laboratories they had contracted, but that a "gradual scaling up of capacity in line with the regions' needs had been assessed as the most responsible management" because analytic capacity is costly. The PHA emphasised that the main responsibility for testing was placed with the regions (117). The PHA announced that they would support the regions in enhancing analytic capacity even further (about half of all analyses were at that time carried out by laboratories contracted by the PHA), for instance by contracting with more laboratories that the regions could use and ensuring that the contracted laboratories increased their staffing (118). This was linked to an extension of the assignment initiated June 4 for the PHA to secure the conditions for large-scale testing. The extended assignment included measures to meet the need for large-scale testing that had occurred because of the rapid spread of the virus and measures to secure preparedness for a scenario of extended and even higher spread (119). Thus, on **November 19**, there was a new agreement between the government and SALAR concerning COVID-19 testing during 2021, which in large part was a continuation of the agreement for 2020 (from June 11). For example, the government agreed to take on the costs for all PCR-tests and the regions agreed to prioritise PCR-tests before serological tests in case of capacity deficiencies. A representative of the PHA pointed out that testing capacity in the regions was currently strained and called on people not to be tested without symptoms or guidance from a physician (120). Furthermore, some debaters suggested that it was irresponsible to expand testing without any limits, because it could crowd out other important tests the regions needed to carry out, such as cervical screening tests (121). **During the period November 16–22**, the number of confirmed cases increased by 2.1% from the week before (31,975 new cases) and 260,710 individuals were tested (11.9% positive). In total, there had been *221,780 confirmed cases* since the outbreak (122).

On November 27, the PHA presented new guidance on rapid tests that had previously been regarded too uncertain, but was now assessed to be a complement to the more certain, but more time consuming PCR-tests (123, 124). The PHA and the government authorised an increased use of rapid tests in some contexts such as eldercare homes (125). The increased use of rapid tests was extended to healthcare and social care in an agreement between the government and SALAR on December

18, with the aim of finding asymptomatic infected staff members (126). The agreement meant that the government would fund the use of rapid tests and the regions would carry them out (127). The week before Christmas, 287,428 individuals were tested and the number of new confirmed cases was 46,210 (16% positive) (128). The last weekly report from the PHA for 2020 summarised a total number of *462,470 confirmed COVID-19 cases during the year*, with 8,443 deaths among people with confirmed COVID-19 (129).

DISCUSSION

As the detailed description illustrates, the build-up of COVID-19 testing in Sweden during 2020 was a highly complex enterprise with a number of national and regional actors involved with partly different views on their respective roles, responsibilities and interpretations of the laws and regulations. An important aspect of the process is that mass testing was a new area for coordination, because it was an unplanned feature for a pandemic response. In general, the description shows ambiguities in the purpose of testing and shortcomings in communication and cooperation during the first half of 2020, but after that an increasing consistency among the crucial actors regarding COVID-19 testing. In the Swedish debate surrounding COVID-19 testing, there was a lack of explicit reference to WHO and ECDC guidance.

During 2020, the Swedish Agency for Public Management concluded that three aspects of the Swedish public administration model constitute challenges for integrated action during a crisis such as the COVID-19 pandemic, when decisions need to be made quickly and with incomplete information, but with the usual governance tools. Two of these aspects are crucial to understanding the events surrounding COVID-19 testing during the first year of the pandemic: (i) the large and independent government agencies and (ii) self-governing regions and municipalities. Linked to both these aspects is the responsibility principle (130).

Large and Independent Government Agencies

Sweden has comparatively large government agencies that have extensive independence even if they are subject to the government. The agencies have a delegated responsibility for handling issues within their areas of responsibility and are important in handling a crisis such as the COVID-19 pandemic, without needing to wait for instructions from the government to act (130). In the case of COVID-19 testing, this is illustrated by the fact that there was no formal government steering of the PHA during the two months after the first confirmed case. The first government assignment to the PHA came at the end of March: to increase the number of tests and to develop a national COVID-19 testing strategy. However, the government was not satisfied with the rate of increase in the number of tests in the following one and a half months after the national strategy was published on April 17, and therefore increased its steering through a new assignment to the PHA on June 4: to secure the conditions for large-scale COVID-19 testing for *anyone with symptoms*. In addition, there was increased government involvement, which was reflected, for example, in the number of times testing was addressed in the media by the Minister of Health and Social Affairs. The government also appointed a national test coordinator in May, to be placed at the PHA to coordinate the dialogue with the regions regarding large-scale testing for COVID-19 and to increase the pace of testing. The government and the PHA thus came to work partly in parallel, at times sending mixed messages. This suggests the need for increased coordination among actors at the national level and potentially also for more national steering and coordination in the case of COVID-19 testing than what was possible through the PHA.

Discussing the role of the PHA in COVID-19 testing, it is important to notice the distinction between *taking* COVID-19 tests and *analysing* them, because the PHA's responsibility for these two tasks differs. Regarding analysis, one of the agency's tasks is to provide support for quality and methods development at laboratories analysing COVID-19 tests (and other types of tests important for communicable disease control) and to maintain the required laboratory preparedness (131). Their responsibility to the regions is further clarified in the agreement between the regions and the PHA, which specifies that the agency is responsible for "securing that the health services has access to the analysis capacity needed for the country's infection control" (132). The detailed description illustrates that the PHA was much more involved in securing and enhancing analysis capacity across the country during 2020 than in the logistics for taking tests (much of the global guidance also focused on analysis capacity). For example, according to the agreement between the government and SALAR from June 11, the PHA was to secure analytic capacity and the agency thus contracted and validated new laboratories and coordinated their efforts with the regions' needs during the autumn (although there was a shortage of analysis capacity during November due to the second wave). In line with this division of responsibility for different aspects of testing, there was a discrepancy between tests taken and the capacity for analysing those tests for several months during the first half of 2020. For example, at the end of May, the analysis capacity had quickly gone up to about 135,000 tests/week, but that many tests were not taken in the regions until the first week of September.

The responsibility of the PHA for *taking* COVID-19 tests–particularly for enhancing the capacity to take tests–was less clear, because tests are taken by the health care services in the regions, and this is generally seen as a regional responsibility (although, as will be discussed below, this too was a question of dispute in the case of COVID-19 testing). Importantly, however, in its capacity as an expert agency, the PHA issued support in the form of recommendations for *whom to test for COVID-19* (17 versions during 2020). Although the PHA's recommendations are non-binding, and the document with testing indications from version 7 (March 9) included some formulations about the possibility for local and regional adaptations depending on the epidemiological situation, these recommendations included a clear order of priority for testing that did not encompass staff in essential services until May 27 (priority group 3) and the

public until June 17 (priority group 4). The first five versions were also labelled *instructions* to the healthcare services about whom to test (later on the terminology testing *indications* was used) and included exposure factors and clinical indications. These recommendations were issued during a time when relatively little was known about COVID-19, such as how to stop the spread and how best to treat people with COVID-19, as well as when it was difficult for the regions to get an overview of the best response in the midst of rapid knowledge development. In line with this, the national coordinator for COVID-19 testing said in the March 25, 2021, hearing by the parliament's constitutional committee that it was clear the regions followed the testing indications from the PHA, which, during May when the slow pace in increasing testing capacity was heavily criticised by the political opposition, for example, was to test priority groups 1 and 2 (11). The Moderate party chairperson of SALAR explained that one reason why it took so long for the regions to start COVID-19 testing for the public in Sweden was that they followed the recommendations from the PHA. He furthermore explained that the regions had not been willing to scale-up to mass testing before they felt they had support from the national authorities (11). Indeed, it is not unlikely that the PHA's testing indications affected the pace of the build-up of testing capacity. It is, however, important to note that this was also intentional to a certain extent. The recommendations served the purpose of securing that the right individuals were tested and that testing was of high quality during a time when high pressure was put on the regions to expand their testing despite a lack of capacity to do so in some cases. Similarly to this, the WHO and ECDC strategies also pointed to the need to prioritise who was tested if the number of suspected cases exceeded the available testing capacity, however continuously pointing to the need to scale-up testing capacity to manage COVID-19.

Linked to this was also the PHA's communication regarding the general *purpose* of COVID-19 testing. The national coordinator's view was that the PHA communicated that testing was not a strategy to suppress the spread of the disease, but to protect the healthcare system (patients and staff) and get people back to work (11). Therefore, in the coordinator's view, there were no incentives for the regions to build up testing capacity and capacity for contact tracing quickly (11). From March 13 to June 17, the PHA communicated that the purpose of COVID-19 testing was to protect vulnerable groups by preventing the virus from spreading within the healthcare and social care services, and that there were no *medical* reasons to test members of the public falling ill with COVID-like symptoms (in line with the PHA's pandemic preparedness plan linked to the WHO pandemic phases, in which mass testing is not mentioned during the pandemic phase). Thus, during the first half of 2020, the efforts in the regions were directed more towards ensuring that the existing testing capacity was reserved for vulnerable groups and healthcare and social care staff than towards enhancing general testing capacity. This was a balancing act between quickly expanding testing while simultaneously avoiding negative side effects such as displacement, which illustrates the discrepancy between the health care service's focus on the individual and the public health-oriented work carried out within communicable disease control. In September, however, the PHA saw contact tracing in combination with generous testing as one of the most important efforts to reduce the spread of COVID-19 and to minimise the number of sick and dead in the population (133).

Self-Governing Regions and Municipalities

In Sweden, a large share of public services such as healthcare and elder care is the responsibility of the self-governing regions and municipalities. Although the *responsibility principle* implies that the **one** responsible for a service/function under normal conditions is also responsible during a crisis situation, many of Sweden's national pandemic responses, such as COVID-19 testing, required measures to be taken within the self-governing regions and municipalities (130). Although self-governing, the government can indirectly steer the regions, for example through assignments to the government agencies to coordinate the regions' work and through targeted government grants. This is a "softer" form of steering than, for example, legislation, which also implies that it is more uncertain what the actual response and result will be come. For COVID-19 testing, the government earmarked funding for testing and contact tracing during the spring of 2020 as well as during the autumn of 2020. In total, the government added substantial resources to increase testing, both to develop testing capacity during the spring and to expand it further during the autumn when the second wave hit Sweden. The government stated that testing would not fail because of a lack of funding.

The government also commissioned the PHA to coordinate the regions' work. As shown above, however, the agency's authority is greater for the analysis component of testing, while it is more restricted regarding logistics related to taking tests. The government can also reach out to SALAR (the organisation representing the regions and municipalities) to communicate and negotiate with the regions, which is a form of soft-law governance that is common in Sweden (130) and usually involves both some economic stimuli and coordination efforts. However, according to SALAR, the dialogue between the government and SALAR regarding COVID-19 testing was not sufficient during the first months of the pandemic. Furthermore, SALAR considered that the government could have consulted SALAR to a much higher extent, which would have been more efficient and would have made the regions more prepared for scaling-up. For example, the regions were not consulted by the government before giving the PHA the assignment to extend testing capacity on March 31. In the parliament's constitutional committee hearing on April 9, 2021, the Minister of Health and Social Affairs said that an earlier agreement with SALAR about large-scale testing would probably have led to a more rapid increase in testing capacity. Although the government allocated substantial additional resources for COVID-19 responses in the regions in general, and to testing and contact tracing more specifically, it was initially handled outside the usual agreement structure between the government and SALAR, which caused uncertainty and a lack of clarity for the regions about the level of additional funding and how they would receive it. This was identified as one reason why there was a delay in the increase in testing capacity (11).

Lack of clarity about the responsibility for COVID-19 testing during the first half of 2020 also delayed the increase in testing capacity (11). There were different interpretations of the

responsibility for testing the different priority groups. According to the Communicable Diseases Act, the PHA is responsible for coordination of communicable disease control at the national level and should take the initiatives necessary to maintain effective communicable disease control (Ch. 1, §7), while each region is responsible for taking necessary communicable disease control measures within the region's area (Ch. 1, §8). The government's standpoint was that all COVID-19 testing (all priority groups) was the regions' responsibility, although they acknowledged that additional funding was needed for the regions to be able to execute the task and thus provided additional funding (11). The Director General of the PHA also stressed that it was the regions' task to test all groups (11). SALAR, however, had a different interpretation of the regions' responsibilities for testing. They did not question the regions' responsibility for testing priority group 1 (inpatients and residents in healthcare and social care institutions) and priority group 2 (healthcare and social care staff), but just for priority groups 3 and 4. This was in part, again, related to the purpose of testing and the different purposes for testing these groups as formulated by the PHA. Based on the PHA's national strategy for COVID-19 testing from April 17, where it was pointed out that there was no *medical* need for a person from priority group 4 (the public) to know whether they had COVID-19, but rather economic and societal benefits if people could return to work (for group 3 as well), SALAR made the assessment that it was not the regions' responsibility to test priority groups 3 and 4 for COVID-19. To get people back to work was not seen as a task that was covered by the regions' responsibility for taking necessary communicable disease control measures within their areas. Up until the end of May, this interpretation was enhanced by the PHA's testing indications, which stated that priority groups 3 and 4 would be included at a later stage. During the same period, however, the Minster of Health and Social Affairs tried to put pressure on the regions to expand testing capacity by presenting a target of 100,000 tests per week to be reached by the end of May and criticising the regions for being slow in building testing capacity.

Throughout 2020, the political opposition criticised the government for not taking control of the testing situation and also for criticising the regions for being slow. Yet, in the Swedish system, it is unclear how far the state's responsibility to create good conditions for regions and municipalities extends (130). Based on the events linked to COVID-19 testing, it can be concluded that decentralised health care systems such as Sweden's may not be entirely effective during a crisis when quick and coordinated action is needed (unless there are well-functioning coordination mechanisms in place). The benefits of this system, such as local democratic practises and services tailored to suit the local population, may be more visible under other conditions. Simultaneously, the importance of place-based approaches in the response to the pandemic has grown, and the importance of leaving room for local initiatives and experimentation in both centralised and decentralised systems has been pointed out (134). It should also be noted that testing was only one of several areas subject to coordination during the pandemic and was surrounded by much complexity and uncertainties throughout 2020. For other areas for coordination, such as securing intensive care capacity, the coordination process might have functioned differently. The problem of quickly building testing capacity has, however, added fuel to the ever-present discussion on whether to reduce the number of Swedish regions or to nationalise the healthcare system. It has also been argued that there should be a change in the constitutional law so that the regions and municipalities could be subordinated to the government in the event of a national crisis to enhance governmental capacity (135). In his article about the first eight months of Sweden's COVID-19 strategy, Ludvigsson (6) argued that a lack of testing in Sweden led to an underestimation of cases. In our article, the purpose was not to discuss how the Swedish COVID-19 testing system affected the spread of the disease, illness in the population or deaths among people with confirmed COVID-19, but this would, however, be a relevant topic for future study, drawing on this description.

Limitations

There are some limitations to this study. Although the description is detailed, it has not been possible to include all events or discussions that may be linked to COVID-19 testing in Sweden during 2020. However, all of the most important events and discussions are covered. Furthermore, this study only covered events, discussions and documents published at the national level by national actors. Even more nuanced descriptions of the build-up of COVID-19 testing in Sweden could be made by analysing regional documents, debates and media coverage. In addition, this study only covered documents and media articles that are publicly available, which means that internal meetings and informal conversations or negotiations were not covered. Informal contacts have been identified as important for the government to clarify their governance. Lastly, other perspectives on COVID-19 testing could be unravelled in interviews with representatives from the regions, SALAR and government agencies such as the PHA, and such a study is under way.

CONCLUSION

During the first half of 2020, COVID-19 testing capacity in Sweden was limited in relation to the spread of the virus and reserved for inpatients, people in institutional care and healthcare and social care staff in order to protect the most vulnerable. The move to mass testing proved to be complex in part due to the responsibility principle in Swedish crisis management, which makes clear that the responsibility of a specific area is to remain with the actor that normally manages it. Because mass testing for viruses is not something that is normally carried out by the 21 self-governing regions responsible for healthcare and communicable disease prevention, and the PHA stated that there was no medical reason to test members of the public falling ill with COVID-like symptoms, the responsibility for mass testing fell through the cracks during the first few months of the pandemic. Through increased government steering and increased communication between the government, the PHA and the regions (SALAR), the question marks around roles and responsibilities for testing were straightened out by the end of

spring 2020, and testing capacity was much increased during the autumn. Until September, the capacity to analyse COVID-19 tests–in which the PHA had a pronounced role–was higher than the regions' capacity to take the tests.

DATA AVAILABILITY STATEMENT

Publicly available data were analysed in this study. This data can be found here: https://www.regeringen.se/sveriges-regering/socialdepartementet/; https://www.folkhalsomyndigheten.se/; https://skr.se/skr/tjanster/press.408.html; https://www.ecdc.europa.eu/en/publications-data/covid-19-testing.

AUTHOR CONTRIBUTIONS

MF planned the study, carried out the majority of the analyses of the empirical material, and drafted the article. AH was involved in collecting the empirical material, critical review of the analyses and the discussion, and was involved in finalising the article. 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.2021.754861/full#supplementary-material

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The Impact of Strict Public Health Measures on COVID-19 Transmission in Developing Countries: The Case of Kuwait

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Background: Many countries have succeeded in curbing the initial outbreak of COVID-19 by imposing strict public health control measures. However, little is known about the effectiveness of such control measures in curbing the outbreak in developing countries. In this study, we seek to assess the impact of various outbreak control measures in Kuwait to gain more insight into the outbreak progression and the associated healthcare burden.

Methods: We use a SEIR mathematical model to simulate the first wave of the epidemic outbreak of COVID-19 in Kuwait with additional testing and hospitalization compartments. We calibrate our model by using a NBD observational framework for confirmed case and death counts. We simulate trajectories of model forecasts and assess the effectiveness of public health interventions by using maximum likelihood to estimate both the basic and effective reproduction numbers.

Results: Our results indicate that the early strict control measures had the effect of delaying the intensity of the outbreak but were unsuccessful in reducing the effective reproduction number below 1. Forecasted model trajectories suggest a need to expand the healthcare system capacity to cope with the associated epidemic burden of such ineffectiveness.

Conclusion: Strict public health interventions may not always lead to the same desired outcomes, particularly when population and demographic factors are not accounted for as in the case in some developing countries. Real-time dynamic modeling can provide an early assessment of the impact of such control measures as well as a forecasting tool to support outbreak surveillance and the associated healthcare expansion planning.

Keywords: COVID-19, public health, mathematical modeling, forecasting, healthcare demand, epidemic outbreak, infectious disease

WHAT IS ALREADY KNOWN ON THE SUBJECT?

Evidence is accumulating about the positive impact of various strict public health interventions on the transmission of COVID-19 in the developed world. Currently, however, many developing countries are still struggling to control and suppress the initial wave of the outbreak. In particular, less attention is given to assessing the impact of taking similar strict control measures.

WHAT DOES THIS STUDY ADD?

Our modeling study provides the first evidence showing how the imposition of strict public health measures has not led to a sizable reduction in COVID-19 transmission in Kuwait. It highlights the importance of performing systematic epidemiological and public health investigations of the population factors which may limit the effectiveness of standard public health interventions in developing countries. It also emphasizes the utility of adopting dynamic modeling approaches for intervention assessment and healthcare capacity re-adjustment at the earliest stages of the outbreak.

INTRODUCTION

In early December 2019, a cluster of pneumonia cases of unknown cause were reported in Wuhan, China (1). Later the pathogen was identified and named, Severe Acute Respiratory Syndrome Corona Virus 2 (SARS-CoV2), an enveloped single strand RNA β-coronavirus with a genome of almost 30 thousand bases (2). Since then the virus has been spreading rapidly all over the globe forcing the World Health Organization (WHO) to confirm the Corona Virus Disease 2019 (COVID-19) as a Pandemic on March 11th, 2020. With the number of cases reaching a staggering 230 million cases in more than 200 countries and a death toll exceeding 4.8 million (3), coordinated worldwide efforts are needed to prepare healthcare systems to cope with this unprecedented challenge. While some countries showed a degree of resilience and capacity to deal with the progression of COVID-19, in others the burden on healthcare systems was overwhelming leading to catastrophic consequences.

Many developing countries are struggling to control the COVID-19 outbreak, and little is known about the effectiveness of public health measures taken by countries with smaller populations and unique demographic profiles such as Kuwait. Kuwait is a small wealthy country with a population of nearly 4.7 million people. On February 24th, Kuwait recorded the first confirmed cases of COVID-19 in four passengers arriving from Iran. Since then, the Ministry of Health have confirmed more than 400 thousand COVID-19 cases and 2,439 deaths (4). Kuwait has implemented early strict control measures in attempt to contain the spread of SARS-CoV2 including: closure of schools, universities, governmental offices and non-essential businesses; full border lockdown, partial curfew and geographic isolation of areas experiencing wide community transmission (**Figure 1**). The situation in Kuwait was further complicated by a remarkable repatriation operation to bring back more than 50,000 Kuwaiti citizens from around the world by May 7th, 2020. The government has implemented home and institutional quarantine measures to limit virus transmission from arrivals. Despite these early and stringent control measures, community transmission remained observed as manifested by the apparent acceleration of case and death numbers well-beyond the anticipated period of slowdown. Hence it was unclear how the outbreak would unfold during first wave as recent contact-tracing measures highlighted the widening community transmission. In addition, the polymerase chain reaction (PCR) testing seems to be constrained by a global shortage of testing kits and reagents posing a threat to smaller countries to get necessary testing tools who now found themselves competing internationally with other countries. In anticipation of the unfolding of such circumstance it became necessary to forecast the potential burden it may incur on local healthcare systems.

Forecasting the outbreak dynamics of COVID-19 cases in Kuwait was crucial to estimating, well in advance, the potential burden on the healthcare system. These epidemic outbreak dynamics are typically investigated by employing mathematical models of infectious disease transmission dynamics such as the classic Susceptible-Infective-Recovered (SIR), Susceptible-Exposed-Infective-Recovered (SEIR) (5–8) or susceptible, exposed, infected, quarantined, and recovered (SEIQR) epidemiological models (9). Such models play a pivotal role in understanding the epidemic characteristics of an infectious disease outbreak (8–10), as well as in assessing the impact of various interventions on the spread of the disease (7, 11–14). Indeed, various high-income countries have previously used these models to help inform their epidemic containment policies (7). Different generalized versions of these mathematical models can provide more detailed mechanisms for the epidemic dynamics (e.g., mode of transmission, quarantine dynamics, testing scope, and hospitalization dynamics). A widely adopted model for characterizing the epidemic outbreak SARS-CoV-2 is the SEIR model (6). However, under-reporting in daily case numbers due to non-optimal testing poses a significant challenge to understanding the trends associated with COVID-19 progression by public health authorities (15). One way to mitigate the impact of this structural limitation is by fitting a dynamic transmission model to daily numbers of incident cases of infections as well as reported deaths (16).

In this study, we model the progression of the COVID-19 outbreak during first wave in Kuwait by developing a generalization of the SEIR model that is informed by two local mechanisms; a delay period during which suspected COVID-19 individuals are tested, identified and hospitalized, and different severity of illness (ranging from recovered asymptomatic to needing critical care). We then calibrate the model by applying a maximum likelihood framework using incident cases of infections and reported deaths (17). We use this framework to assess the effectiveness of public health interventions and forecast the associated healthcare burden in Kuwait.

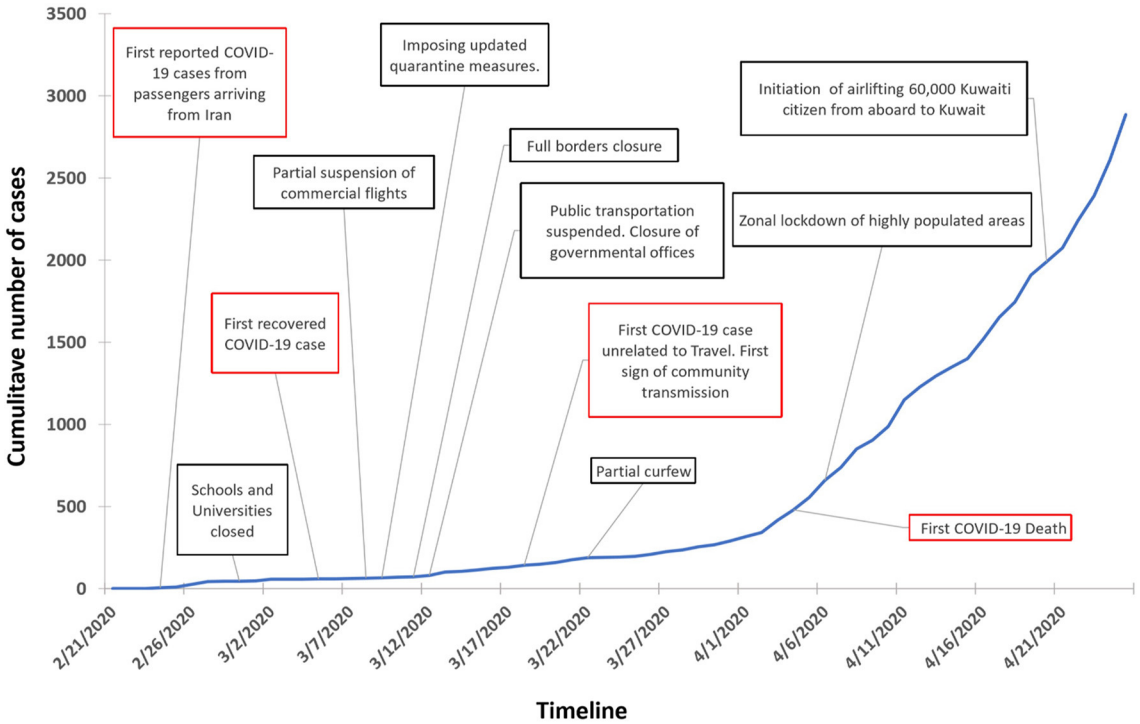

FIGURE 1 | Cumulative number of reported COVID-19 cases in Kuwait along with a timeline of events.

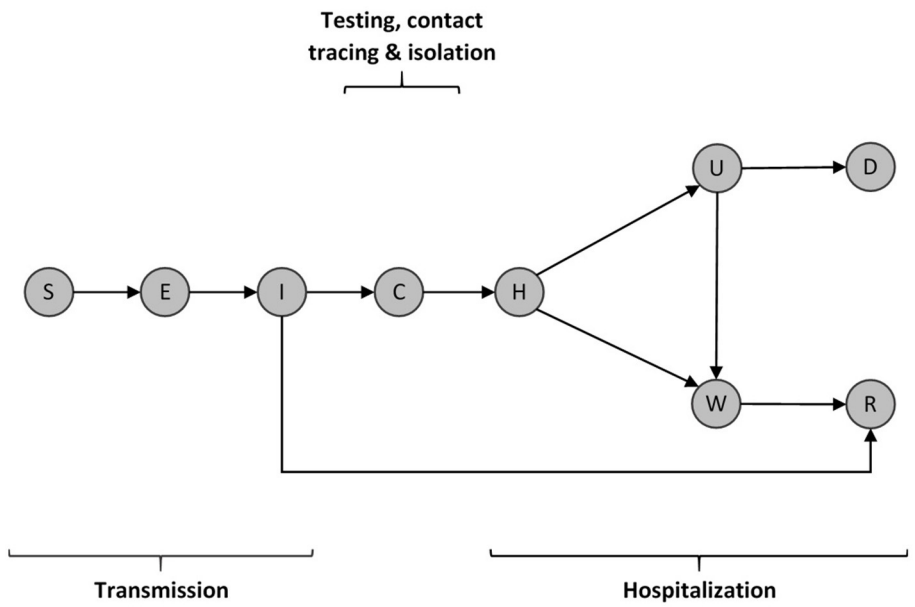

FIGURE 2 | Schematic diagram of the COVID-19 transmission model. Individuals (S) susceptible to the virus become infected by infectious individuals (I). They then move through a latent period (E) before becoming infectious (I). Infectious individuals can either move through a detection period (C) or eventually recover without symptoms. Confirmed infectious individuals move through an initial hospitalization period (H) after which they are admitted to either an isolation ward (W) or an intensive care unit (U). Intensive care patients may recover and be sent to an isolation ward W or ultimately die (D). Isolated patients move through a recovery period (R), where they are assumed to be immune to the disease, at least in the medium term.

TABLE 1 | Model parameters.

Symbol	Definition	Default values	Justification
N	Total population of Kuwait	4,776,000	PACI, Kuwait
S_0	Susceptible subpopulation	500,000	MOH, Kuwait
R_0	Basic reproduction number	1.5–3.5	(19)
κ	Factor for transmission reduction	0.5	
σ^{-1}	Latent period	2 days	(20)
γ^{-1}	Infectious period	3.2 days	(20)
α^{-1}	Onset-to-hospitalization period	2 days	Unpublished data
ω_1^{-1}	Initial hospitalization period	6 days	Unpublished data
ω_2^{-1}	Mean ICU duration until recovery	8.5 days	Unpublished data
ω_3^{-1}	Mean isolation ward duration	10 days	Unpublished data
ω_4^{-1}	Mean ICU duration until death	10.5 days	Unpublished data
f	Proportion of tested & reported daily cases	0.12	(21)
ε_1	Proportion of patients admitted to ICU	0.075	Unpublished data
ε_2	Proportion of ICU patients with death outcome	0.25	Unpublished data
CFR	Case fatality ratio	1.4%	(15)

Rate of testing and the proportion of cases being tested remain largely unknown at this stage but are expected to increase over time as health authorities increase their laboratory testing capacity. The hospital care data were provided by colleagues from the Ministry of Health, Kuwait.

METHODS

Mathematical Model

We use a deterministic compartmental model for infectious disease transmission with additional compartments to describe the dynamic burden on the healthcare system (**Figure 2**). Our model simulates SEIR, testing and hospitalization dynamics and can be described by the following set of differential equations:

$$\begin{aligned}
\frac{dS}{dt} &= -\frac{\beta(t)SI}{N} \\
\frac{dE}{dt} &= \frac{\beta(t)SI}{N} - \sigma E \\
\frac{dI}{dt} &= \sigma E - \gamma I \\
\frac{dC}{dt} &= f\gamma I - \alpha C \\
\frac{dH}{dt} &= \alpha C - \omega_1 H \\
\frac{dW}{dt} &= (1-\varepsilon_1)\,\omega_1 H + (1-\varepsilon_2)\,\omega_2 U - \omega_3 W \\
\frac{dU}{dt} &= \varepsilon_1\omega_1 H - \epsilon_2\omega_4 U - (1-\varepsilon_2)\,\omega_2 U \\
\frac{dR}{dt} &= \left(1-f\right)\gamma I + \omega_3 W \\
\frac{dD}{dt} &= \varepsilon_2\omega_4 U
\end{aligned}$$

Upon infection, individuals who are susceptible to the virus (S) become exposed but non-infectious carriers (E) and later infectious (I). A fraction of infectious individuals may remain undetected and ultimately enter into a recovered class (R), while the remaining fraction end up being detected (C) by some form of clinical testing or diagnosis. Detected individuals are sent to hospitals (H) where they are admitted to either an isolation ward (W) or an intensive care unit (U) based on the intensity of their symptoms. Intensive care patients either die (D) or get sent to an isolation ward to stay until full recovery (R) (**Figure 2**).

The progression through the different compartments in our model is characterized by key time periods which describe the dynamic transmission of infection, case detection, patient care and hospitalization, and recovery or death: the average durations of viral latency ($1/\sigma$), carrier infectiousness ($1/\gamma$), onset-to-hospitalization ($1/\alpha$), onset-to-death, hospitalization-to-discharge, and ICU-stay. The fraction of individuals who end up being detected (f) is related to the case fatality rate. Since the transmission rate β is affected by the implementation of control measures, we take it as a function of time $\beta(t) = \beta_0\kappa(t)$, where β_0 is the transmission rate without control measures (baseline) and $\kappa(t)$ is a positive scaling factor by which interventions may reduce the transmission rate. In other words, κ values smaller than 1 characterize a more effective intervention in curbing the epidemic. Here $\kappa = 1$ indicates an ineffective or absent control measure, with values greater implying improper control measures or non-compliance.

We remark here that the modeling was made possible despite the lack of population health data such as country demographics and associated person-person contact structure. Hence, we assumed homogeneous mixing not accounting for age-structure nor the risk associated with comorbidities. Nonetheless, these can be easily incorporated into our model once detailed data become available.

Data and Parameters

Numbers of confirmed infection and death cases were collected from daily reports from the European Center for Disease Control (18). All our data sources are outlined in **Table 1**. The key time durations in our model were fixed to values

obtained from published datasets as well as unpublished local hospitalization data. The mean durations of latency, incubation and infectiousness of SARS-CoV-2 ware based on the reported cases from the COVID-19 outbreak in Singapore and Tianjin, China (20).

We assume that a single case started the outbreak on February 24th, 2020, which coincides with the date of the first reported case of COVID-19 in Kuwait. The total population of Kuwait (N) is about 4,776,000. We note here that our model parameter estimation is insensitive to the number of susceptible individuals as long as the number of cases is small relative to N. We take the initial unprotected susceptible population to be 500,000 which is the effective number of individuals who account for the majority of local community transmission in Kuwait. This estimate is consistent with the assumptions that (1) the majority of the population has been protected by the stay-at-home orders, (2) most community transmission cases are localized to certain geographic areas, and (3) children younger than 18 years old represent a very small percentage of the total number of infected patients. However, we also model 1,500,000 susceptible individuals and show the corresponding results.

To assess the impact of control interventions, we assume $\kappa(t) = 1$ prior to the implementation of a partial lockdown on March 22, 2020 (**Figure 1**). We then estimate κ and the baseline transmission rate β_0 by employing a maximum likelihood framework (17). To derive the maximum likelihood estimates (MLE) of our unknown parameters we assume the daily numbers of incident infections are detected according to a negative binomial distribution (NBD). We additionally assume the daily number of incident deaths are drawn from a similar distribution. Then optimization was carried out using the Nelder-Mead method (22) on the combined minus log-likelihood function.

The uncertainty of parameters was represented by quantile-based credible intervals (CI). We use the asymptotic normality of MLE to account for such uncertainty through deriving simulation-based 95% CIs for the model curves (23). Simulations were run 10,000 times based on random draws of the unknown model parameters from a normal distribution $\beta, \kappa \sim N\left(\hat{\theta}, \Sigma\right)$. Here $\hat{\theta} = \left(\hat{\beta}_0, \hat{\kappa}\right)$ are maximum likelihood estimates and Σ is the variance-covariance matrix associated with them. Given the parameterization of our transmission model, these parameters permit a model-based estimation of the basic and effective reproduction numbers. In particular, in each simulation run an R_0 value is drawn from a range of values (**Table 1**) as an initial point to kick start the parameter search algorithm. Our transmission model was fitted to estimate key transmission parameters. The maximum likelihood estimates of the baseline and effective transmission rates, β_0 and β_e were used compute the basic and effective reproduction numbers *via* these formulas

$$R_0 = \frac{\beta_0}{\gamma}, R_e = \kappa R_0.$$

All simulations, parameter estimation and model calibration were run in the R software (24).

RESULTS

Our estimated basic reproduction number is $R_0 = 1.43$ (95% CI: 1.33–1.58). Interestingly, the MLE of the factor by which control measures reduce transmission was estimated at $\kappa = 1$ (95% CI: 0.9998–1). This corresponds to an effective reproduction number $R_e = R_0$, which is consistent with reports from the Center for Mathematical Modeling of Infectious Diseases (25).

We remark here that our model-based estimates of the reproduction numbers, which directly influence the prevalence of the epidemic, depend on the values we adopt for the incubation and infectious periods (**Table 1**). In particular, larger periods are expected to lead to higher values for the reproduction numbers. For example, we find $R_t = R_0 = 1.97$ (95% CI: 1.85–2.12) if we change the incubation and infectious periods to 5 and 6 days, respectively.

Our parameter estimations captured the variation around the observed number of reported cases and deaths to project a posterior distribution of the expected numbers. Our projected trajectories and their 95% credible intervals were able to capture the early slow increase in observed cases, hospitalization and deaths (**Figure 3**).

Under the current testing rate, capacity and scope, the model projects the daily numbers of reported cases to peak around 480 (95% CI: 300–680) by the second half of the month of May. In terms of the burden on the healthcare system, our model projects peak hospital admission of 8,000 patients (95% CI: 5,000–12,000) with ICUs projected to peak around 350 patients (95% CI: 220–480). At these rates the model projects a peak daily mortality around 8 deaths (95% CI: 5–12). We additionally explored a scenario that simulates an expansion in the size of the susceptible subpopulation by a factor of three (**Figure 4**). A summary of the projected epidemic and healthcare burdens is presented in **Table 2**.

DISCUSSION

We developed a mathematical modeling framework for real-time tracking and forecasting of the epidemic outbreak of COVID19 in Kuwait and the associated burden on the healthcare system. This quantitative framework is further employed to evaluate how the control measures implemented in Kuwait may have influenced the epidemic burden. Such tools can derive important policymaking decisions. Insight from Kuwait can potentially inform similar policies, programs and public health measures taken by other developing countries.

Our results suggest that the early gradual and stringent control measures in Kuwait had the effect of delaying and lowering the intensity of the outbreak by protecting a large fraction of the population. Despite the fact that the country has been under lockdown since March 22nd, 2020, our model indicates that the effective reproduction number (R_e) remained unchanged. In principle, such control measures are implemented to achieve a sufficient reduction in the effective reproduction number during an outbreak. This may be explained by the reported outbreaks amongst migrant workers (26). Kuwait has a considerably

heterogenous population with 60% comprised of non-nationals. A large proportion of these workers cluster in certain areas and live in cramped dormitories with poor and unsanitary housing conditions (27). Strict social distancing measures may not be implementable nor have the same effect on these subpopulations. Hence, this could exacerbate the transmission of the infection in the presence of lockdowns. It is therefore imperative, for the epidemiological understanding of the disease distribution, to perform demographic studies that aim to extract contact structure matrices and establish how different control measures may or may not affect heterogenous transmission rates (28). This is not only applicable to the State of Kuwait, but also the Arabian Gulf states, Singapore and other countries with somewhat similar demographic profiles.

Additionally, our results indicate that the COVID-19 outbreak in Kuwait is on course to accelerate further in the next few weeks, which is consistent with the recent trends associated with expanded testing and contact tracing. Indeed, our model analysis of the projected epidemic trend indicates that hospitals may need to prepare for admitting around 12,000 patients of which 500 may need critical care.

This work has a number of limitations. First, we did not have detailed data on age structure, nor the risk associated with comorbidities. Younger individuals have lower risk of mortality and morbidity from COVID-19, while older people with comorbidities will have significantly higher case fatality ratio. If most of the recorded cases in Kuwait were young, then this might have led us to overestimate the results. In contrast, if the older or comorbid population was higher in Kuwait, we would be underestimating the results. The direction of the bias is critical when adopting this model. Secondly, many parameters were derived from unpublished data obtained from local hospitals in Kuwait. Although the parameters may change as the data are growing, we do not anticipate significant departure from the values presented in this work. Thirdly, we did not have demographic information. Careful consideration should be taken with regards to population heterogeneity, especially migrant workers. Further investigation with geospatial

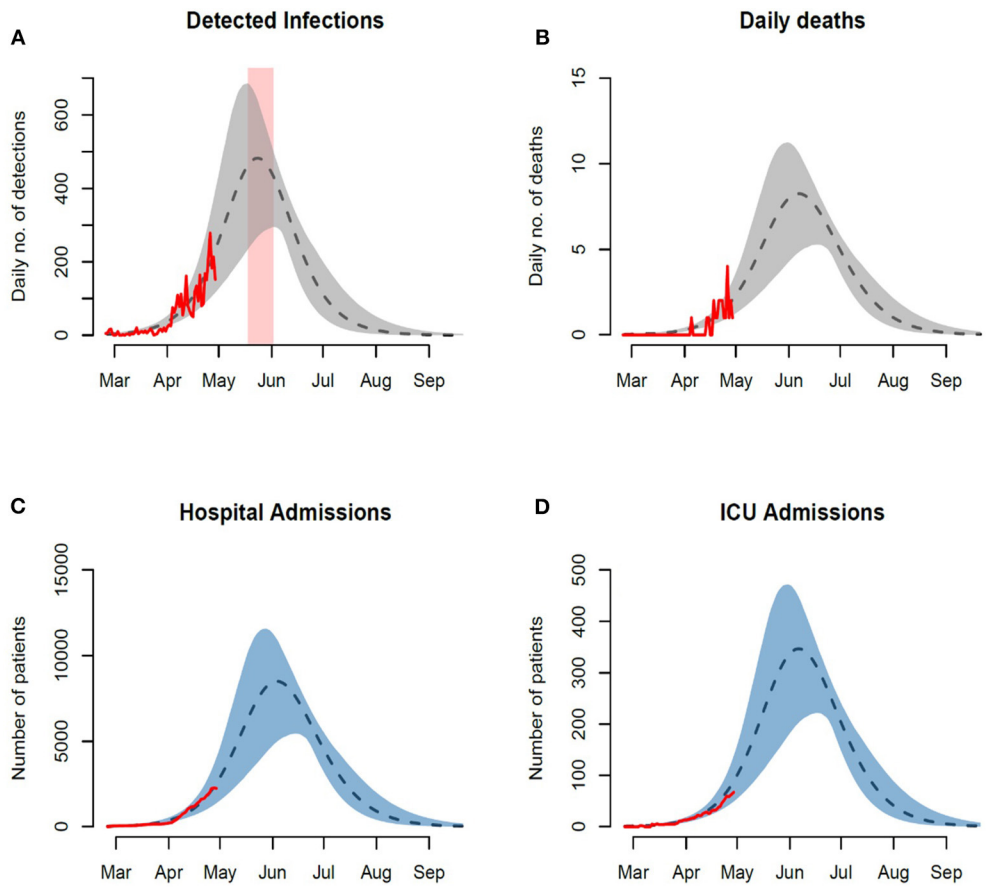

FIGURE 3 | Observed and forecasted trajectories assuming 500,000 unprotected susceptible individuals. Observed and projected daily numbers of **(A)** incident infections, **(B)** death cases, **(C)** general hospital admissions, and **(D)** ICU admissions. Red rectangular ribbon highlights the projected time-window of the epidemic peak. Red lines represent the reported data. Black dashed lines represent model projections based on MLE of unknown parameters with shaded ribbons representing 95% credible interval on new observations. We note here that the observed cases and their projections only represent a fraction of the actual and model prevalence. This is based on our assumption of under-reporting and the presence of asymptomatic individuals in the population.

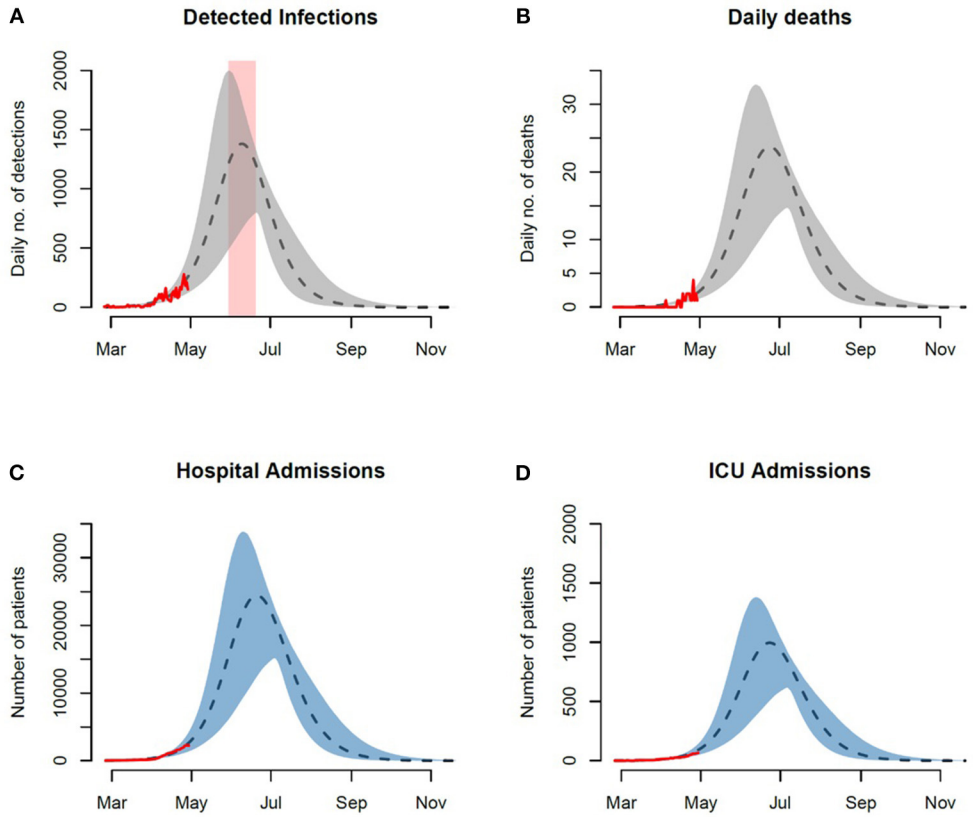

FIGURE 4 | Tripling the size of the unprotected susceptible population. Peaks of forecasted trajectories are approximately tripled in size. The projected time-window of the peak is delayed by 2-weeks and widened (3-week period). Observed and projected daily numbers of **(A)** incident infections, **(B)** death cases, **(C)** general hospital admissions, and **(D)** ICU admissions. Red rectangular ribbon highlights the projected time-window of the epidemic peak. Red lines represent the reported data. Black dashed lines represent model projections based on MLE of unknown parameters with shaded ribbons representing 95% credible interval on new observations. We note here that the observed cases and their projections only represent a fraction of the actual and model prevalence. This is based on our assumption of under-reporting and the presence of asymptomatic individuals in the population.

TABLE 2 | Projected epidemic and healthcare burdens.

Expected burden	500,000 Susceptibles	1,500,000 Susceptibles
Max reported cases	480 (300–680)	1,400 (800–2,000)
Max hospital occupancy	8,000 (5,000–12,000)	25,000 (15,000–35,000)
Max ICU occupancy	350 (220–480)	1,000 (600–1,400)
Max daily mortality	8 (5–12)	24 (15–33)
Peak time-window	15 May—3 June	1 June—20 June

Burden projections based on model simulations are presented. Uncertainty is represented by 95% credible intervals.

mapping to understand epidemic clusters is warranted. Finally, the complemented R code and real data from Kuwait should not be uncritically applied without careful tailoring to specific study settings and revisiting of the assumptions.

CONCLUSIONS

COVID-19 poses significant public health challenges to many developing countries including Kuwait. We have shown that stringent control measures can effectively delay and lower the intensity of the outbreak. However, they might not be sufficient to completely halt the transmission of the disease in the presence of certain structural restrictions pertaining to population and demographic factors. In turn, this highlights an urgent need for a systematic reassessment of public health interventions to account for demographic heterogeneities. Such an assessment needs to be supported by modeling tools to monitor the impact on the outbreak progression. In particular, our model can serve as a public health tool for decision makers to guide in the control of the current outbreak, even in the absence of critical population health data. This replicable tool can also be used to anticipate effective future measures should a second wave re-emerge in Kuwait and other developing countries. In addition, it can serve as a public health tool to track and control the current outbreak.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors upon reasonable request.

AUTHOR CONTRIBUTIONS

AA-S was involved in the conception and design of the study, analysis and interpretation of data, and drafting the article. HA was involved in acquisition, analysis and interpretation of data, and drafting the article. BA was involved in analysis and interpretation of data. FA-R was involved in interpretation of data. SA-S, MJ, and AA was involved in acquisition of data. QA-D was involved in was involved in revising the article critically for important intellectual content. FA-M was involved in analysis and interpretation of data and gave the final approval of the version to be submitted. All authors contributed to the article and approved the submitted version.

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Are We Better-Off? The Benefits and Costs of Australian COVID-19 Lockdown

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INTRODUCTION

When compared with other countries, Australia has fared much better in COVID-19 outcomes, having experienced low COVID-19 cases, hospitalisations, and deaths. Although it is difficult to know with certainty what and to what degree led to these advantageous outcomes, many attributed this success to the early implementation of strict border closure limiting cross-border transmission and being an Island nation (1–3). Australia has been proceeding with the elimination strategy aiming to contain and crush emerging outbreaks quickly through a suite of public health interventions, with lockdowns playing a central role. However, as vaccination rates continue to rise in Australia, we opine that the lockdowns and other stringent non-pharmaceutical interventions should be phasedown as the cost to the individuals, community, and the economy is likely to outweigh the benefits of these restrictions.

At the beginning of the pandemic, most countries followed and defended the implementation of lockdowns, with the early calculations suggesting that benefits far outweigh the costs (3–5). Some empirical studies also observed heterogeneity in the effectiveness of lockdowns and advocated for a careful consideration of demographic, economic, and societal factors before implementing stay-at-home orders, especially in developing countries in which many people rely on day-to-day economic resources (6, 7). However, using more recent data, others provided a different assessment arguing that lockdowns cause more harm than good even in developing countries—with the benefit-cost ratio being significantly overestimated (8, 9). Considering the burden of prolonged lockdown that Sydney and Melbourne have been experiencing and taking into account the increasing vaccination rates across the country, our governments need to carefully consider when and how to lift lockdown and other restrictions, as there is no doubt the cost of getting this wrong is very high.

Following a critical review by Allen (10), we discuss the issues associated with the evaluation of lockdown costs and benefits and provide an opinion on lockdowns doing potentially more harm than good as Australia achieves high vaccination rates. This may be useful in timely discussions among the public, media, public health officials, and decision-makers.

Issues in Cost-Benefit Analyses

Firstly, by following an intuitive argument that lockdowns reduce transmission of the COVID-19 infection, the direct benefits should include the reduction in the number of cases, hospitalisations, and deaths. However, by how much? To answer this, the counterfactual scenarios that should be explored are those that would represent what would have been the level of disease burden if lockdown hadn't been implemented. One must be cautious with the studies that used the "Do-nothing" or unrealistic counterfactuals, which significantly inflate the benefits of lockdowns. As we have seen, almost all, if not all, countries have implemented various other control and suppression

measures, and individuals changed their behavior voluntarily in order to reduce the transmission of COVID-19 infection (11).

Secondly, several studies evaluated the impact of lockdown through changes in COVID-19 basic or effective reproduction number, which describe the contagiousness or transmissibility of COVID-19 infectious agents in epidemiological models (12, 13). These models do not take into account the fact that individuals change their behavior endogenously and can respond to the rising risks of being infected. Ignoring these endogenous individual adjustments is likely to overestimate the lockdown benefits in terms of the number of daily cases, hospitalisations, and deaths.

Thirdly, relying on the number of deaths averted due to the lockdown as a key input in the benefits calculations is not enough. In the case of COVID-19, clinical evidence indicates that elderly (and nursing home residents) and those with co-morbidities are at significantly higher risk of experiencing adverse COVID-19 health outcomes, including death (14, 15). Consequently, while reporting the number of deaths is an important indicator, the cost-benefit analysis would benefit from focusing on the residual life-expectancy of the average COVID-19 death, which then can be used to infer the number of life-years saved due to the lockdown.

Lastly, to estimate the benefits of lockdown in monetary terms, many studies relied on the economic concept of the value of a statistical life (VSL), which is calculated by observing individual willingness-to-pay for a (small) reduction in mortality risk (5, 16, 17). Population-average VSL estimates generally are elicited by examining the trade-off between wages and occupational hazards among working adults—excluding those not in the labor force. Using these population-average VSL estimates (seen in many earlier works) is hardly appropriate and may significantly overestimate the benefits since the elderly and those with co-morbidities experience higher fatality risks and generally have lower VSL. Another difficulty in identifying appropriate VSL estimates to COVID-19 deaths is that the VSL for the elderly group is highly uncertain. This makes it critical to explore the sensitivity of the results to VSL estimates and associated COVID-19 attributes that may influence them.

Apart from the issues raised in evaluating the benefits, the calculation of costs has also been problematic and often does not correspond to the full burden of prolonged lockdowns a society experience. Most studies evaluated the costs of lockdown through the loss of GDP, or in other words, the lost output, and foregone services. From a practical perspective, this is a straightforward approach due to the data availability, including high-frequency datasets from private companies. Similar to the evaluation of the benefits, the selection of the counterfactual is important to calculate the costs, as some of the costs would have occurred due to other restrictions and voluntary behavior changes.

In addition to GDP losses, lockdowns are associated with significant societal, health, and economic costs—which needs to be taken into account, especially if the VSL approach is used. If the evaluation of lockdown benefits relies on a dollar measure of utility people derive from living, then the costs should also be guided by the losses in utility; hence focusing only on the GDP losses would largely underestimate the "true" costs of lockdowns. Some of the non-monetary but tangible impacts include losses in human capital due to schools' closure and educational disruptions, losses in health outcomes due to delayed medical procedures, and losses in mental and physical well-being due to increased anxiety levels, domestic violence, and lack of physical exercise. It is challenging to be comprehensive and account for all costs due to the lockdown, but by evaluating more significant and visible of those costs, one can get closer to the actual cost of lockdown or at least establish a lower bound for the costs and more carefully compare it with the benefits.

Worth also considering in decision-making is the equity concerns with respect to who benefits and who suffers in the prolonged lockdowns. Epidemiological evidence suggests that young people are much less likely to have health consequences from COVID-19, but experience higher costs of lockdowns in terms of lost educational and employment opportunities, lost social connections, and an increased risk of adverse effects on their mental health (18–20).

DISCUSSION

Evaluating the costs and benefits of lockdowns in the Australian context is particularly important. It is one of the very few countries which has pursued the elimination strategy (successfully for the most part) and now trying to shift from stringent public health measures as the vaccination rates rise. Complementing timely public health response to the pandemic, Australians have shown high compliance and trust in government and health services (21). Together with the government, they have been adjusting quickly to changing environment (especially during the outbreaks). Accounting for these endogenous changes in behavior regarding increasing or decreasing risks of getting infected helps avoid the overestimation of the lockdown benefits.

Lockdown benefits significantly depend on whose lives we are saving and look at the residual life-expectancy of the average COVID-19 death. Lally (22) estimated this measure lies between 4.7 and 5.5 years for Australia using the data from the first waves of the pandemic when most of the deaths occurred among nursing home residents and those with multiple co-morbidities. In the current context of the delta strain affecting the population more generally, especially once the lockdown restrictions are lifted, these estimates will require upward adjustment. Conservative estimates would be around 10–12 years in residual life expectancy using data from the U.S. and Sweden, where the virus had been established in the community (22, 23). Furthermore, it may also be reasonable to adjust these estimates downward to account for the quality of those residual years.

With respect to the costs, capturing non-economic costs of the pandemic is an important and challenging task. Costs associated with depression, anxiety, and well-being have represented a significant burden of the lockdown. In Australia, recent research supports these findings that there was a considerable decline in community mental health in adults due to the pandemic-related restrictions (24).

CONCLUSION AND RECOMMENDATIONS

In light of the futility and detrimental impacts of lockdowns and increasing vaccination rates across the country, we recommend:

- A shift from a zero-covid policy to a COVID-19 management plan which should outline the details of how and at what stages the lockdown and other public health restrictions would be lifted.
- Moving forward, the use of lockdowns or movement restrictions should be limited and target only outbreaks in areas with a high proportion of unvaccinated people, particularly in disadvantaged and remote communities.
- Shift away from reporting COVID-19 cases and focus on reporting geographically specific health system capacity and deaths once the lockdown approach is phased out. This should be a part of the COVID-19 management plan preparing the community to live with COVID-19.
- When evaluating the impact of lockdowns retrospectively and for future planning, a broad societal perspective should be adopted to estimate the benefits and costs of lockdown.
- Also, a systematic approach to evaluate lockdowns is needed, which will allow for updating the benefit-cost ratio more frequently in response to the changes in epidemiological and economic situations.

There is no illusion that there are trade-offs, but the question that begs an answer is whether we can be better off as a community without lockdown restrictions? In the context of Australia with soon-to-be-reached 80% vaccination targets, and hence the relative reduction in the lockdown benefits, we are of the opinion that it warrants the transition away from lockdown-centered policies.

AUTHOR CONTRIBUTIONS

AP conceived the idea, wrote the draft, and revised the paper. OA wrote the draft and revised the paper. EM conceived the idea and revised the paper. All authors contributed to the article and approved the submitted version.

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Learning From Each Other in the Management of Natural Disaster and COVID-19 Pandemic: A Case Study in Taiwan

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In response to the COVID-19 pandemic, Taiwan has been one of the best performers in the world with extremely low infections and deaths. This success can be attributed to the long experiences dealing with natural disasters and communicable diseases. However, with different disastrous characteristics, the disaster management systems for communicable diseases and natural disasters are very different in terms of laws, plans, frameworks, and emergency operations. Taking the response to COVID-19 pandemic as a study subject, we found that disaster management for communicable diseases can be improved through a comparison with natural disasters, and vice versa. First, having wider and longer impacts than natural disasters, the plans and framework for communicable diseases in Taiwan focus more on national and regional scales. Local governments would need more capacity support including budgets and training to conduct investigations and quarantine during the COVID-19 pandemic. Second, for quick response, the emergency operation for communicable diseases was designed to be more flexible than that for natural disasters by giving the commander more authority to adjust to the circumstances. The commanding system requires a more objective consultation group to prevent arbitrary decisions against the COVID-19 pandemic. Finally, risk governance is important for communicable diseases as well as for natural disasters. Additional efforts should be made to enhance vulnerability assessment, disaster reduction, and risk communication for shaping responses and policies in an efficient and coordinating way.

Keywords: COVID-19, communicable disease, natural disaster, disaster management, emergency operation

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INTRODUCTION

The novel coronavirus disease 2019 (COVID-19) pandemic, caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), and named by the International Committee on Taxonomy of Viruses (1), has been rapidly spread worldwide since the end of 2019 and has resulted in great impacts on health, society, economics, and the environment (2–4). To slow down the spread of this epidemic, many countries have implemented non-pharmaceutical intervention policies such as travel restrictions, social distancing policies, quarantine, and lockdowns (5). Nevertheless, by Jun 30, 2021, the infections of COVID-19 continued to rise with over 182 million confirmed cases and 3.9 million deaths in over 190 countries (6).

Taiwan is one of the best performers in confronting the COVID-19 pandemic in the world. According to the COVID-19 infection statistics in **Figure 1**, Taiwan had only 1,290 infections and 12 deaths in total (54.16 infections and 0.50 deaths per million) before May 14, 2021. Although Taiwan experienced a sudden rise of infections to 14,804 people (621.58 infections and 27.21 deaths per million) in the period of May 15 to June 30, 2021, the overall infections are still much lower than those in the United States (101,706 infections and 1,827 deaths per million), the United Kingdom (70,962 infections and 1,891 deaths per million), the Netherlands (99,957 infections and 1,052 deaths per million), Australia (1,202 infections and 36 deaths per million), and Canada (37,699 infections and 696 deaths per million).

Taiwan was one of the first to respond to the COVID-19 pandemic by inspecting passengers for fever or pneumonia symptoms on direct flights from Wuhan since COVID-19 was firstly reported in December 2019 (7, 8). On January 5, 2020, Taiwan Centers for Disease Control (TCDC) informed the passengers who had traveled to Wuhan within the previous 14 days with symptoms of an upper respiratory tract infection (URTI) to conduct quarantine at home or in a hospital if medical attention was necessary. On January 20, 2020, a level-3 epidemic command center was activated and implemented relevant strategies such as laboratory diagnosis, border control, community transmission control, medical system response and preparedness, stockpile and allocation of personal protection equipment, health education, and disinformation management (details can be found from the website of the CDC at https://www.cdc.gov.tw). Some advanced technologies were applied to monitor the COVID-19 pandemic, including a mask-rationing plan to limit personal mask purchase in the beginning of pandemic outbreak, a digital fence system to monitor if someone does not stay in the assigned place during quarantine, a communication APP based on LINE chatbot to answer questions automatically, and a short-message-service (SMS) real-name registration system to track someone's footprint if an infection is confirmed. These strategies and advanced technologies successfully suppressed the infections to a very low level in Taiwan for more than 1 year. However, the COVID-19 infection finally broke through the line after the outbreak of a cluster infection at a quarantine hotel in May 2021 due to the loose isolation and triage measures, lack of vaccination, and insufficient widespread testing.

Disasters involve many aspects of community, government, and nongovernmental functions. In fact, Taiwan has established comprehensive disaster management systems based on decades-long experience of fighting with natural disasters and communicable disasters (9). While communicable disasters are categorized as biological disasters in Taiwan, in the response to the COVID-19 pandemic, we found that the disaster management systems and corresponding operations for communicable disasters are very different from those for natural disasters. The COVID-19 crisis is considered as a long-term public health emergency rather than most natural disasters with temporary damages to the built environment such as flooding. This is because the scales of life loss, economic impact, and social disruption caused by COVID-19 pandemic are much larger than those caused by natural disasters. Taking Taiwan as an example, the international communications of academy, commerce, and travel have stagnated for nearly 2 years since the implementation

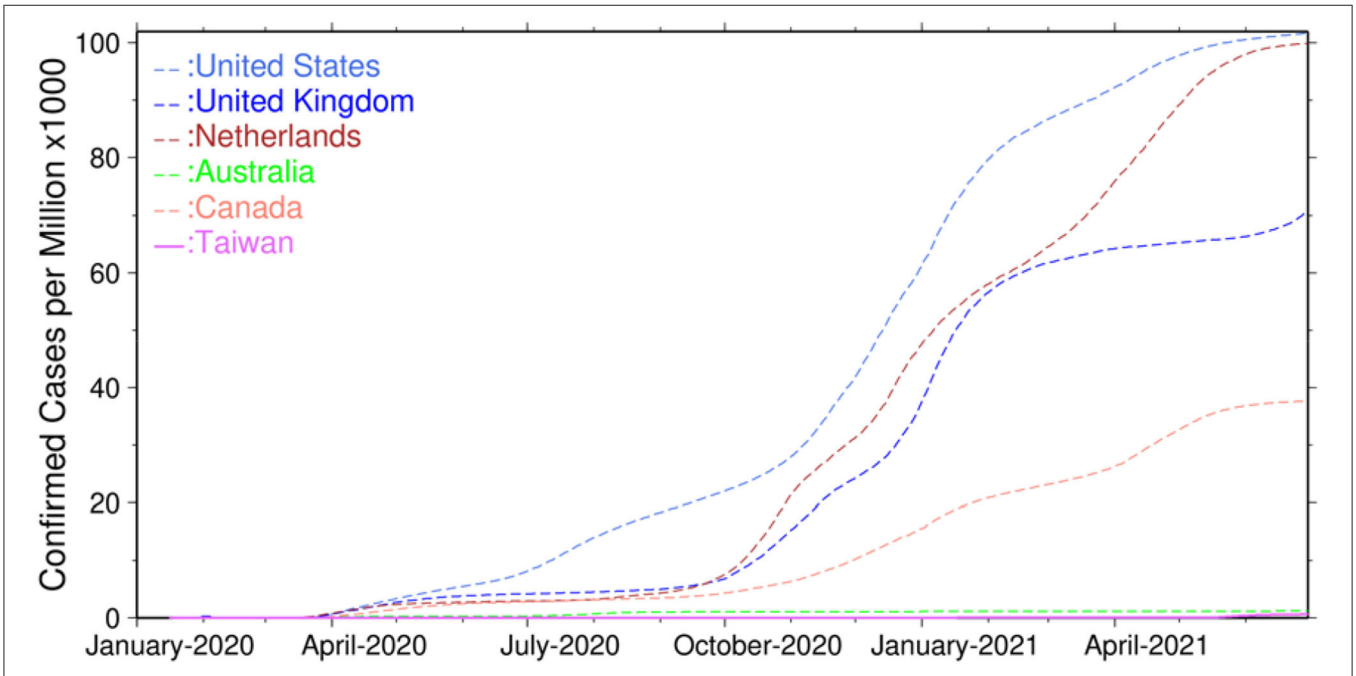

FIGURE 1 | Confirmed infections of COVID-19 worldwide.

of border control in March 2020. This was never happened for natural disasters such as floods, typhoons, and landslides which normally lasted for serval days and only caused traffic interruption between local communities. While some impacts caused by COVID-19 stop, the others may continue in different forms. Understanding how the two disaster management systems are structured and functioned is crucial for shaping responses and policies in a more efficient and coordinating way.

The comparison of management systems for natural disasters and COVID-19 diseases has been conducted by a few researchers (10–12). Some studies showed that there are conflicts between the two systems that need to be fixed, whereas some indicated that one system may benefit from the other. For example, Simonovic et al. (13) pointed out that maintaining social distance can be very difficult during emergency evacuation for natural disasters in the COVID-19 pandemic period because the former requires collaboration but the latter requires isolation. Ishiwatari et al. (14) indicated that existing disaster-management measures should be restructured to protect human life and security during the COVID-19 pandemic, which required health and disaster related organizations to coordinate and share information based on scientific knowledge (15). Dzigbede et al. (16) showed that the existence of preparedness, response, and recovery mechanisms for natural disasters helps to combat the COVID-19 pandemic through the investigation of local government capacity in the United States. Among the Caribbean islands, Hambleton et al. (17) indicated that the slowing down of COVID-19 spreading can be attributed to the early border controls issued under the collaborative framework of Caribbean Community (CARICOM), established since 1973 in response to seasonal hurricane threats.

Taking the COVID-19 epidemic experience in Taiwan as an example, this study aims to compare the disaster management systems as well as the experiences in responses and operations for communicable disease and natural disasters in terms of the evolution of laws, plans, frameworks, and emergency operations. Through an overall inspection and mutual learning, lessons can be learned to improve the disaster management systems for both communicable disease and natural disasters. The findings will be valuable for other regions in the response to COVID-19 pandemic during subsequent waves.

METHODS

This study aims to explore the structures and functions of the emergency management systems in Taiwan and how they influence the responses to natural disasters and COVID-19. First, we comprehensively reviewed the corresponding laws, regulations, operational plans, program reports, literatures, and official press releases for communicable diseases and natural disasters. Then, we conducted interviews with experts and officials from central and local governments involved in the disaster management system in Taiwan as well as local village representatives for their inputs on identifying the lessons that should be learned. The selection of interviewees was based on the representativeness of the roles and experiences in dealing with natural disasters or pandemics. The main inclusion criteria is that the participants must have been involved in managing natural disasters or pandemics for at least 3 years. The backgrounds of the interviewees are listed in **Table 1**. Each interview lasted half-an-hour to 2 h depending on each interviewee's time availability. In total, two from central government, six from local government, and three local villagers were interviewed. Some key interview questions are listed as below:

TABLE 1 | Backgrounds of interviewees.

Code	Position	Field
CG1	Central Government	Natural Disaster
CG2	Central Government	Natural Disaster and COVID-19
LG1	Local Government	Natural Disaster and COVID-19
LG2	Local Government	Natural Disaster and COVID-19
LG3	Local Government	Natural Disaster and COVID-19
LG4	Local Government	COVID-19
LG5	Local Government	Natural Disaster
LG6	Local Government	Natural Disaster
LV1	Local Village	Not Applicable
LV2	Local Village	Not Applicable
LV3	Local Village	Not Applicable

- Based on your experience, what are the differences between natural disasters and biological disasters in terms of characteristics and disaster responses?
- Have you observed any conflict or inconsistency between Disaster Prevention and Response Act and Communicable Disease Control Act? If yes, what are they?
- How do you follow Disaster Prevention and Response Act and Communicable Disease Control Act in your professional responsibility during the COVID-19 pandemic? Please try to describe in terms of disaster prevention, mitigation, preparedness, response, and recovery.
- Do you know the regulations of Central Epidemic Command Center, and its legalized timing, level, and organization of establishment? How about the Central Emergency Operation Center?
- What do you think about the performance of Central Epidemic Command Center so far?
- What are the interactions have you observed or been involved in between the Office of Disaster Management and the Health Bureaus during the COVID-19 pandemic?
- Do you know All-Hazard Approach in managing disasters? Would you prefer it to the current management system? Why or why not?

INTERVIEW RESULTS

The suggestions and feedbacks from the interviewees in **Table 1** are summarized as below:

- Although Taiwan had experiences dealing with SARS in 2003, the current pandemic provides many lessons to learn (CG 1, CG2, LG1, LG2, LG3, LG4).

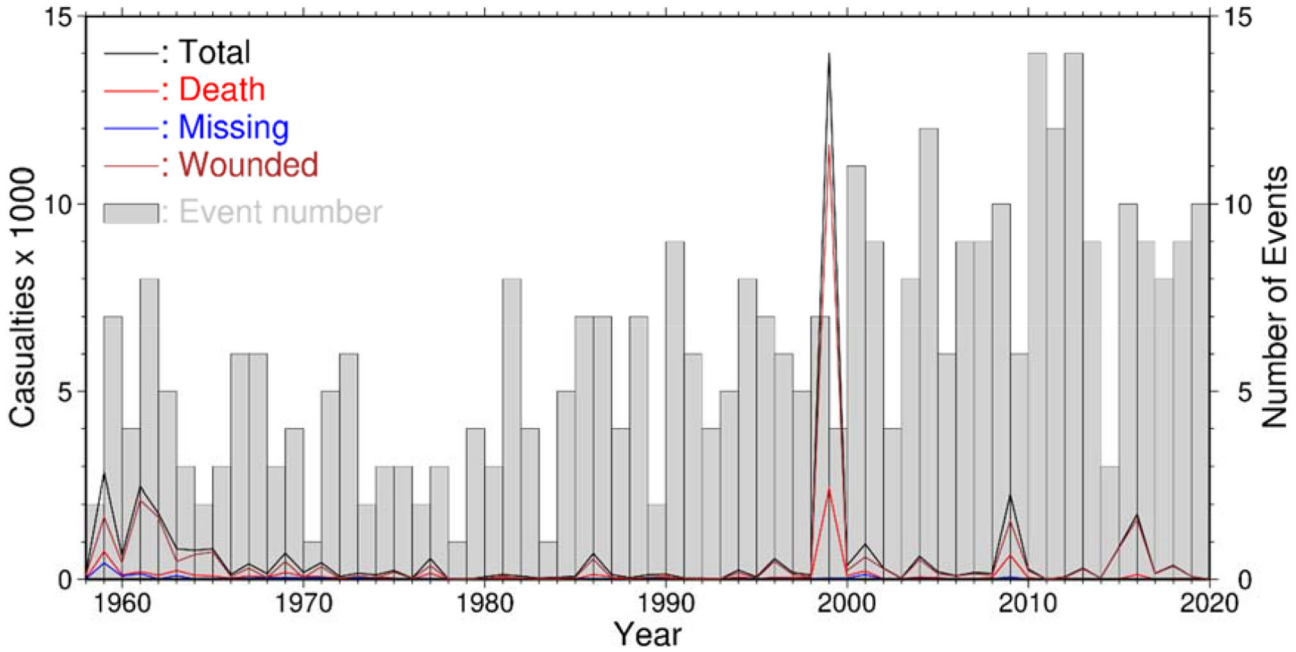

FIGURE 2 | Annual number of natural disasters and corresponding casualties from 1958 to 2019.

- The establishment and operations of emergency operation center and epidemic command center are two entirely different systems (CG 1, CG2, LG1, LG2, LG3, LG4, LG5, LG6).
- Being two different systems, the roles and tasks in dealing with these two disasters are sometimes overlapped or conflicted. It requires intensive communications and coordination. A commander's experiences plays an important role (LG1, LG2, LG3, LG4).
- COVID-19 competes medical capacity of other diseases and reduces the willingness of non-COVID patients to seek medical treatment (LG1, LG2).
- Medical resources can be well allocated across regions under the current system, highlighting the importance of regional network (LG1, LG2, LG3).
- The disaster management framework for communicable diseases does not include the township level as it does for natural disasters. In response to the pandemic, township officials are required to assist investigations and arrange medical treatment which might be beyond their capacity. It appears township officials do not necessarily have sufficient training due to lack of resources (LG3, LG4, LV1, LV2).
- Risk communication is critical. The daily press conference held by Central Epidemic Command Center receives public attention widely, however the released information focused more on numbers of confirmed cases and their travel histories, rather than a holistic risk assessment (CG1, CG2, LG5, LG6).
- Translating knowledge into languages that public can understand is important and still needs more efforts (CG1, CG2, LG1, LG2, LG3, LG4, LG5, LG6, LV1, LV2, LV3).
- Risk maps can be a useful tool to better allocate resources (CG1, CG2, LG1, LG6).
- Taiwan may consider all-hazard approach as a whole, especially for the response stage (CG1, LG1).

EVOLUTION OF THE DISASTER MANAGEMENT SYSTEMS IN TAIWAN

Natural Disasters

Taiwan is one of the most vulnerable areas in the world suffering from various kinds of natural disasters (18) including typhoons, floods, earthquakes, and landsides which have caused many casualties annually as shown in **Figure 2** (19). In the figure, the annual events of natural disaster showed an increasing trend after 2000 but the casualties did not increase simultaneously. This can be attributed to the passing of Disaster Prevention and Response Act (DPRA) in 2000, which enhanced the management system and reduced the impacts caused by natural disasters. **Figure 3** shows the evolutions of the disaster management and the disaster history in Taiwan, which can be divided into two periods: the pre-DPRA period from 1945 to 1999 and the post-DPRA period after 2000. During the early stages of the pre-DPRA period, Taiwan experienced several severe natural disasters, two of which were the flooding on August 7, 1959 and the Paiho earthquake on January 18, 1964. The resulted casualties were 1,075 and 756, respectively. The government focused on providing subsidies to the victims affected by natural-disaster-induced casualties and house collapses through executive orders. In 1994, the government realized that the subsidy-based policy may be inadequate in response to devastating disasters such as the Los

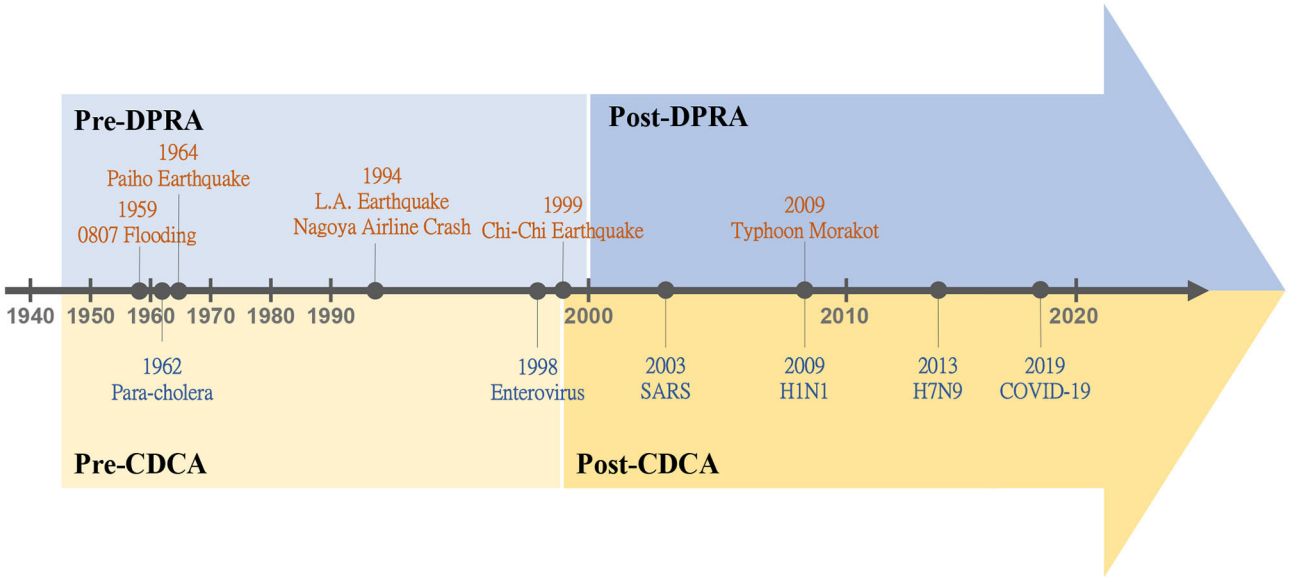

FIGURE 3 | The evolutions of disaster management systems for natural disasters and communicable diseases in Taiwan (where DPRA represents Disaster Prevention and Response Act; CDCA represents Communicable Disease Control Act).

Angeles earthquake (60 deaths and 9,000 injuries) and the China Airlines' flight crash in Nagoya (264 fatalities). The Executive Yuan proposed the Disaster Prevention and Protection Plan (DPPP) in the same year to deal with prevention, responding, and recovery relating to natural and man-made disasters.

On September 21, 1999, the Chi-Chi earthquake hit central Taiwan, causing 2,415 deaths, 30 missing, 11,305 injuries, 11,000 house collapses, and countless infrastructure damages, with total economic loss amounting up to 12 billion US dollars. This devastating earthquake promoted the legislation of the first disaster management law, the DPRA, in 2000. On August 8, 2009, the heavy rainfall brought by Typhoon Morakot resulted in severe landslides, flooding, and 664 deaths. The catastrophic disaster led to an amendment of the DPRA in which the Office of Disaster Management was established with full-time employees to supervise and implement the policies of national disaster management. More details about the history of natural disaster management in Taiwan can be obtained from Chuang and Ho (9).

Communicable Disease

In **Figure 3**, disaster management for communicable disease in Taiwan can be divided into two periods: the pre-CDCA (Communicable Disease Control Act) period from 1945 to 1998 and the post-CDCA period after 1999. In the pre-CDCA period, there were several major communicable disease events in Taiwan, such as the para-cholera outbreak in 1962 and the enterovirus outbreak in 1998. To deal with these epidemics, the Department of Health (DOH) established in 1971 as a directorate general for health affairs was upgraded to the Ministry Of Health and Welfare (MOHW) in 2013. The DOH established several subordinate organizations to implement epidemic prevention works, including the Department of Epidemic Prevention (DEP), the Institute of Preventive Medicine (IPM), and the General Quarantine Office (GQO). In the pre-CDCA period, all policies and measures for epidemic preventions were regulated by the Communicable Disease Control Regulations (CDCR).

In 1999, the CDCR was revised and renamed as the CDCA, and the DEP, GQO, and GQO were combined into the TCDC and became the authority of disease control to take charge of disease prevention, quarantine, surveillance, and inspection in Taiwan. In 2003, the severe acute respiratory syndrome (SARS) struck Taiwan with a total of 668 likely infected cases and 181 deaths (20). The Taiwan government undertook a series of countermeasures that successfully stopped the spread of the epidemic, such as quarantine, community surveillance, and infection prevention network (13, 21). During the next year, the National Health Command Center (NHCC) was established to bridge the information among central, regional, and local authorities in support of decision making during epidemic times. The NHCC has made great contributions during several serious epidemics in recent years, such as the H1N1 Influenza outbreak in 2009, the H7N9 Influenza epidemic in 2013, the Dengue Fever epidemic in 2015, and the current COVID-19 pandemic, as shown in **Figure 3**.

COMPARISONS BETWEEN THE DISASTER MANAGEMENT SYSTEMS FOR NATURAL DISASTERS AND COMMUNICABLE DISEASES

Based on the evolution of disaster management systems in Taiwan, the comparison between natural disasters and

communicable diseases on their laws and plans, management framework, and emergency responses are described as below.

Laws and Plans

In Taiwan, the disaster management systems for all disasters are regulated by the DPRA, in which each disaster is governed by one ministry when it comes to policy planning and emergency operation. For example, the Ministry of the Interior (MOI) is in charge of typhoon and earthquake disasters, the Ministry of Economic Affairs (MOEA) is responsible for flood disasters, the MOHW takes care of biological disasters, and the Ministry of Transportation and Communications takes care of air crash disasters. The corresponding ministries may propose different plans for different disasters in terms of mitigation, preparedness, response, and recovery. According to the DPRA, the Executive Yuan should announce the basic DPPP as the principal guideline for central ministries to establish disaster-based operational DPPPs and for local governments to follow and establish their own local DPPPs. In other words, the DPRA and basic DPPP provide general rules for all kinds of disasters, whereas the operational and local DPPPs are specific regulations for different disasters and areas. Hence, the budget and penalty for managing different disasters are different. For instance, the fine for spreading fake news for biological disasters is USD 180,000, which is much higher than that for natural disasters as of USD 36,000. According to the operational DPPPs, the annual budget for biological disaster prevention is 22 million USD, whereas that for typhoon disaster prevention is 4.3 million USD.

Based on the DPRA, disaster management in Taiwan includes four phases: mitigation, preparedness, response, and recovery. For each disaster, the responsible ministry should propose related plans to strengthen disaster management in each of the four phases. These laws and regulations work mainly under a command-and-control model as authorities could design a plan and expect people to follow it. For instance, the MOI implemented Disaster Management Capacity Building Plans in 2009 to increase the abilities and capacity of prevention, protection, and collaboration across county, township, and village levels against typhoons (22). To scientifically support the plans proposed by different ministries, the Ministry of Science and Technology has promoted a series of major plans to develop key technologies for disaster prevention and reduction, including the National Science and Technology Program for Hazard Mitigation from 1999 to 2006, the Program on Strengthening the Technology for Disaster Prevention, Reduction, and Implementation from 2007 to 2010, the Program on Applying Science and Technology for Disaster Reduction from 2011 to 2018, and the Innovative Service Program for Disaster Prevention and Reduction Technology from 2019 to 2022. In these programs, updated technologies and platforms are used to bridge the research energy of academic units, the resources of the central government, and the needs of local governments.

In 2016, communicable diseases were officially categorized as one kind of biological disaster and since after regulated by the MOHW under DPRA. Interestingly, according to the operational DPPP for biological disasters, policy plaining and emergency response for communicable diseases should follow the instructions of the CDCA. This makes the CDCA a special act even though biological disasters are regulated by DPRA. In the last 20 years, the MOHW has implemented several national plans for communicable disease control, namely the National Influenza Pandemic Preparedness Plan from 2005 to 2021, the Acute Infectious Disease Risk Monitoring and Management Plan from 2014 to 2019, and the Plan for preparing and response to severe infectious pneumonia during the COVID-19 period.

The laws and plans for natural disasters and communicable diseases are summarized in **Figure 4**. Compared to the plans for natural disasters with an equal emphasis on the four phases, the plans for communicable diseases focus more on epidemic preparedness and response. In addition, the plans for natural disasters root deep into the township and village levels, whereas the plans for communicable diseases emphasize collaboration on national and regional scales. The main reason is that local efforts and awareness are critical in response to immediate disasters such as flooding, while communicable diseases, such as COVID-19, can easily spread across regions and nations which makes regional coordination more important.

Framework

In Taiwan, the framework for natural disaster management comprises three levels: the central government, county governments, and township governments, as shown in **Figure 5A**. At the central level, the Offices of Disaster Management (ODM), the Disaster Prevention and Protection Council (DPPC), the Disaster Prevention and Protection Commission, the Disaster Prevention and Protection Expert Committee, and the National Science and Technology Center (NCDR) were established under the Executive Yuan to support policy making for disaster prevention, protection, and emergency response on a national scale. At the county and township levels, DPPCs and ODMs were also established to make policies on refugee organization, disaster reports, and victim rescue on local scales.

When disasters happen, a Central Emergency Operation Center (CEOC) is established under the commanding of ministers appointed by the convener of central DPPC according to the characteristics of disaster. For a compound disaster associated with different ministries, multiple ministers can be appointed as associated commanders at the same time to provide necessary support. After the establishment of the CEOC, the county and township governments are immediately notified to establish corresponding emergency operation centers locally.

According to the CDCA, the disaster management framework for communicable diseases also comprises three levels: the central government, regional networks, and county governments, as shown in **Figure 5B**. The MOHW is in charge of disaster management in the central government to prevent and control communicable diseases on a national scale. Unlike with natural disasters, disaster management for communicable disease lacks the township government level but has an additional regional level lying between the central and county government levels. At the regional level, neighboring counties are grouped up into six regional medical networks to set up communicable disease

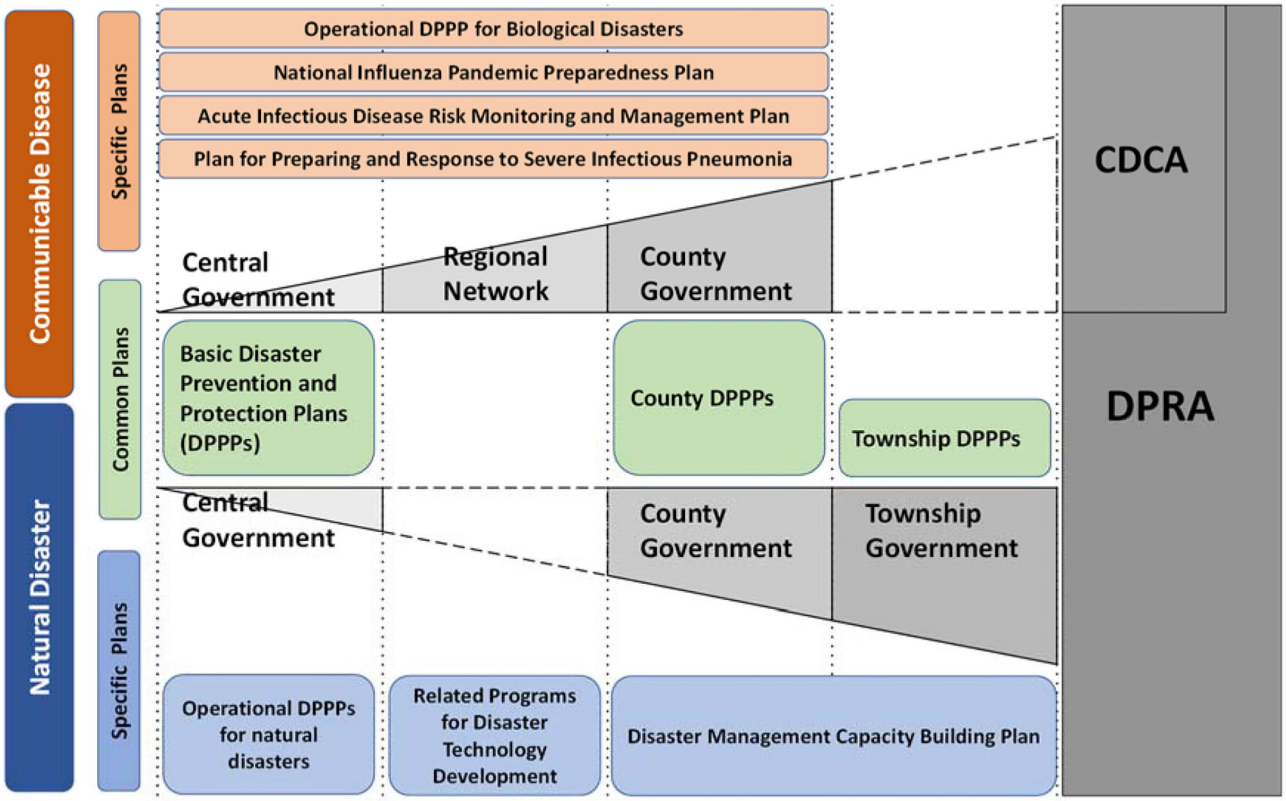

FIGURE 4 | The laws and plans for natural disasters and communicable diseases.

isolation wards and coordinate essential medical supplies for communicable disease control. At the county government level, health bureaus are responsible for implementing the policies and plans formulated by the TCDC, and conducting disease control measures commissioned by the NHCC.

According to the CDCA, communicable diseases are classified into five categories according to the level of fatality rate, incidence rate, and transmission speed. When communicable diseases occur or are expected to occur, local governments should immediately report to the TCDC and take necessary countermeasures in accordance with their authority and responsibilities. In consideration of the severity of epidemic conditions, the NHCC may establish a Central Epidemic Command Center (CECC) to integrate resources, organizations, and personnel across different governmental levels. Regional medical networks and county governments should establish relevant epidemic command centers to execute the instructions from the CECC.

Emergency Operation

For different kinds of disasters, the timing and levels for the establishment of CEOC are illustrated in **Figure 6**. Some disasters, such as floods, droughts, and debris flows, are more predictable and observable through scientific analysis, so they have explicit timing for establishing a specific level of CEOC. Some disasters, such as tsunamis and earthquakes, can be observed but happen too fast to classify emergency levels. Some disasters, such as radiation and biological disasters, are invisible and therefore unpredictable for defining the timing and levels for emergency operation.

The organizations of the CEOC for natural disasters are displayed in **Figure 7A**, which comprises four sections and 20 groups. Each group comprises serval agencies with a leader to fulfill specific tasks for disaster emergency operations. For example, the disaster evaluation group, which is responsible for data gathering, damage analysis, early warning, and decision support, is led by the NCDR with members of the MOI, the MOEA, the Council of Agriculture, the Environmental Protection Administration, the Council of Indigenous People, the National Fire Agency, the Construction and Planning Agency, the Central Weather Bureau, the Directorate General of Highways, and the Ministry of Transportation and Communications. During an emergency period, the agencies from different groups station in the CEOC and work in shifts to provide all necessary support. Information and resources are constantly exchanged and updated through intergroup meetings.

Since the COVID-19 pandemic is classified as a kind of communicable disease and is governed by the MOHW, the MOHW established the CECC in January 2020 with the organizations shown in **Figure 7B**. Compared with the CEOC

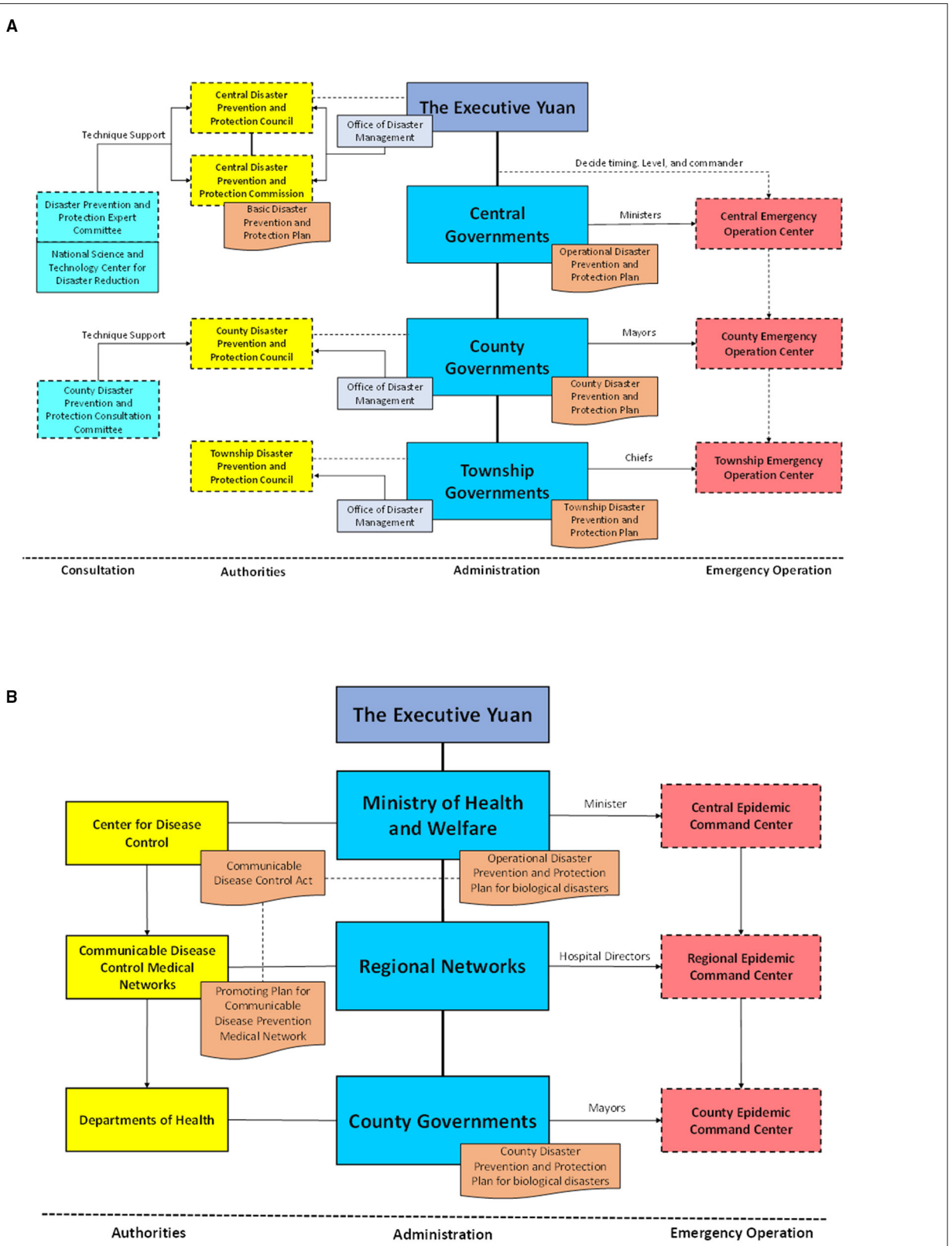

FIGURE 5 | Disaster management frameworks in Taiwan for **(A)** natural disasters and **(B)** communicable diseases.

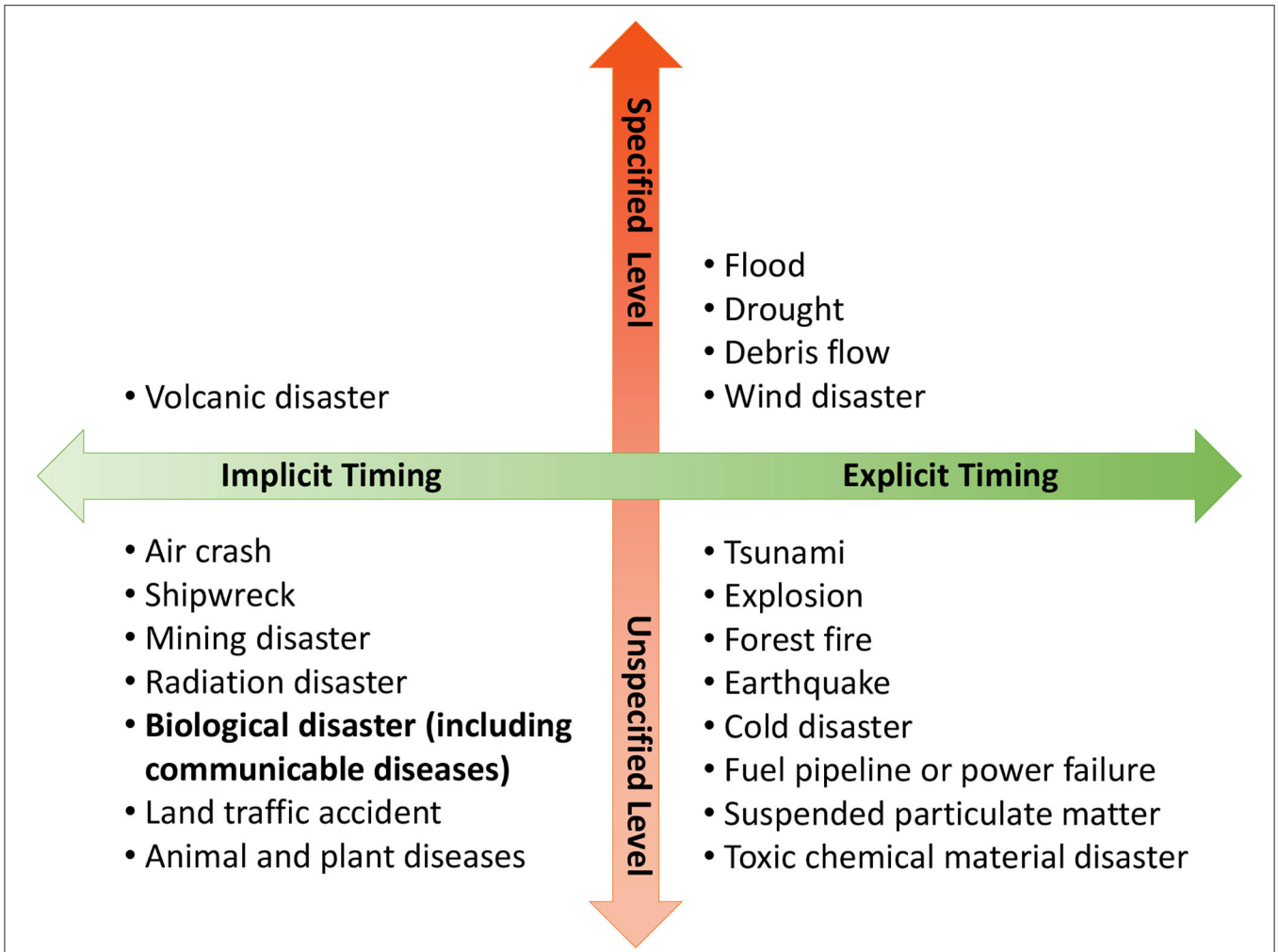

FIGURE 6 | Timing and level to establish central emergency centers for different disasters.

for natural disasters, the organizational structure of the CECC is more flexible and less complicated than that of the CEOC. In the intelligence section, tasks related to pandemic monitoring are directed by the TCDC in cooperation with the Department of Policy Planning and the Ministry of Foreign Affairs only. Unlike the CEOC for natural disasters, the agencies required to station in the CECC are not explicitly regulated and can change with the circumstances according to the commander's decision. This arrangement might be efficient and effective, but the information seems not be transparent enough to the stakeholders, and the performance of the CECC may rely too much on the commanders' experience.

LESSONS LEARNED

Fill in the Missing Links

The enactment and enforcement of laws are especially important for creating a supportive environment for disaster management (23). As mentioned earlier, the disaster management framework for communicable diseases is regulated by the CDCA in Taiwan, which does not include the township government level as it does for natural disasters. However, in response to the COVID-19 pandemic, township officials are required to assist investigations and arrange medical treatment for people with respiratory tract symptoms during the period of home quarantine. Without being explicitly tasked in the framework or regulated by laws, township officials may lack adequate training and easily get confused when conducting the tasks. As stated by one of the interviewees from the local government, local health centers and healthcare workers are the front lines that need to be included in the overall plan, such as DPPP and CDCA, for adequate allocation of resources.

In contrast, the disaster management framework for natural disasters is insufficient at the regional scale because regional networks are not included in the DPRA. During the COVID-19 pandemic, the regional networks played a crucial role in responding to the nosocomial infections occurred in January 2021 by receiving patients from different hospitals. The benefits and coordinating functions of regional networks have been positively agreed by all the interviewees. Without regional networks, the resources across counties cannot be effectively

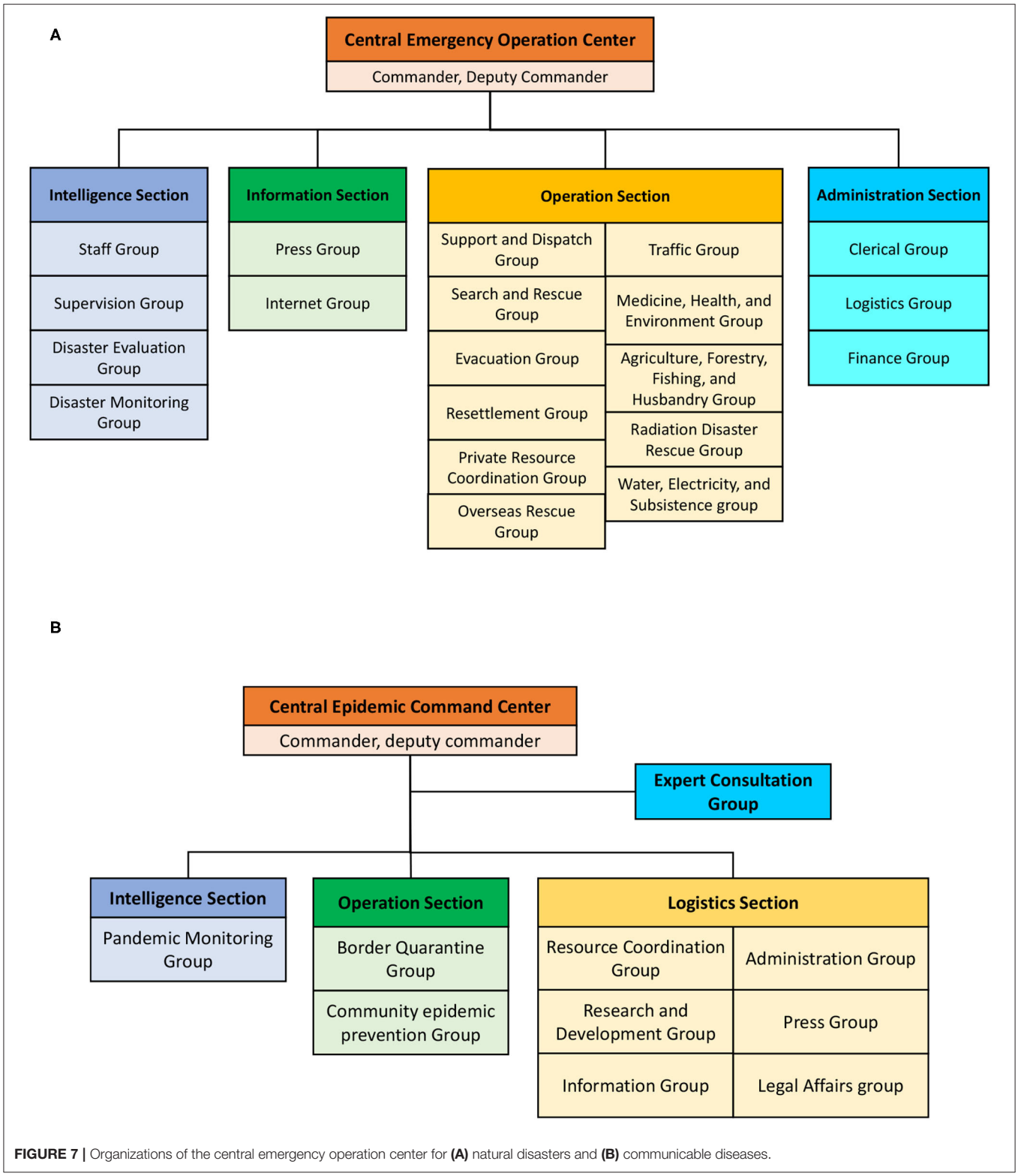

FIGURE 7 | Organizations of the central emergency operation center for **(A)** natural disasters and **(B)** communicable diseases.

coordinated if a disaster affects a region across counties. For example, during the cornstarch explosion disaster in the Formosa Fun Coast Waterpark in 2015, the local county did not have enough ambulances to transport victims and some requests for assistance from neighboring counties were delayed (9). This finding is supported by the United Nations Development Programme (24), '*the public authorities, civil servants, media, private sector, and civil society should coordinate at community,*

national, and regional levels in order to manage and reduce disaster and climate related risks.' Overall, regarding both natural disasters and communicable diseases, the missing links in the disaster management systems need to be addressed.

Moreover, as pointed out earlier and shown in **Figure 4**, DPRA regulates biological disasters, but policy plaining and emergency response for communicable diseases should follow the instructions of the CDCA. This created confusions. For instance, the timing for establishing a local epidemic command center is described inconsistently in CDCA and DPPP — the former authorizes local governments to decide the timing when there is a need but the latter regulates that the a epidemic local command center must be established immediately once a central one is established. According to our interviewees from both the central and local governments, the establishment and operations of emergency response center and epidemic command center are apparently two entirely different systems. Although they do not see significant drawbacks in running the two systems separately, they do have different roles and tasks that are overlapped or conflicted in dealing with these two disasters.

Passing Down the Knowledge

Moe et al. (25) indicated that disaster management practitioners should be innovative and adopt the best practices based on the experience and lessons from previous events. RICS et al. (26) emphasized that disaster recovery experience should be applied to improve the resilience of communities and to reduce disaster risks in the future. Mohanty et al. (27) indicated that knowledge can be divided into explicit and tacit knowledge. Explicit knowledge can be accessed by anyone through books, pictures, or guidelines, but tacit knowledge is learned from individual experience and can be lost with the person possessing it. In the last half century, the disaster management systems in Taiwan evolved with the knowledge learned from devastating disasters through the explicit amendment of laws to establish the ODM and NHCC after Typhoon Morakot in 2009 and the SARS pandemic in 2003, respectively.

However, as indicated in previous sections, the timing, level, and organization for establishing a CECC are not explicitly stated in the CDCA. This gave the commander more authority to adjust the operation systems according to the rapidly changing situations of the COVID-19 pandemic. However, this has pros and cons because the performance of disaster operation is highly dependent on the commander's experience and knowledge. In contrast, the operation of a CEOC for natural disasters is explicitly regulated in the DPRA, which may be less flexible, but the knowledge inherent in the regulations can be passed down to different commanders. To prepare for the next global pandemic, the experience gained from the fight against the COVID-19 pandemic must be transformed to explicit knowledge or regulations that can be accessed by others.

Enhance Disaster Risk Governance

According to the guidelines of the Sendai framework (28), the governance of disaster risk is emphasized, which includes the understanding of hazard, vulnerability, and exposure to disasters; the recognition of stakeholders' roles; and the resilience of health infrastructure. The disaster risk management cycle proposed by RICS et al. (26) indicated that sustainable development can be achieved by reducing the risk and vulnerability of local communities in the pre-disaster phase. To achieve this, the government must establish appropriate frameworks of laws, regulations, and policies to define the roles and responsibilities of both public and private sectors. However, through the comparison between the DPRA and CDCA, we found that both fundamental laws lack the considerations of vulnerability assessment, risk communication, and recognition of stakeholders' roles. Relevant amendments should be made accordingly to enhance disaster risk governance in the future.

CONCLUSIONS

Although Taiwan has been one of the best performers in the world in response to the COVID-19 pandemic, the disaster management systems for communicable diseases still have room for improvement through a comparison with those for natural disasters. Being regulated by different laws, the disaster management systems for communicable diseases and natural disasters are different in terms of framework, plans, and emergency operations. Compared with that for natural disasters, the framework for communicable diseases lacks the township level, which may have resulted in the undertraining of frontline staff in assisting people with respiratory tract symptoms during the COVID-19 pandemic. In contrast, the framework for communicable diseases possesses regional networks that efficiently coordinated the medical resources across counties during COVID-19 pandemic. For emergency response, the operation center for communicable diseases is more flexible by giving the commander more authority to adjust the timing, level, and organization according to the circumstances. However, this also implies that the performance of emergency operation is more dependent on the commander's level of experience. Finally, both fundamental laws for natural disasters and communicable diseases should be amended by including concepts concerning disaster risk governance, such as vulnerability assessment, risk reduction, and sustainable development.

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.

AUTHOR CONTRIBUTIONS

W-LL, S-HY, and C-WL: analysis. H-WW and J-HJ: review and editing: H-WW and C-LS: supervision. H-WW: project administration. All authors contributed to the article and approved the submitted version.

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frontiers in Public Health

COMMUNITY CASE STUDY
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Engaging Religious Institutions and Faith-Based Communities in Public Health Initiatives: A Case Study of the Romanian Orthodox Church During the COVID-19 Pandemic

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The success of public health interventions is highly dependent on the compliance of the general population. State authorities often implement policies without consulting representatives of faith-based communities, thereby overlooking potential implications of public health measures for these parts of society. Although ubiquitous, these challenges are more readily observable in highly religious states. Romania serves as an illustrative example for this, as recent data identify it as the most religious country in Europe. In this paper, we discuss the contributions of the Romanian Orthodox Church (ROC), the major religious institution in the country, to the national COVID-19 mitigation efforts. We present not only the positive outcomes of productive consultations between public health authorities and religious institutions but also the detrimental impact of unidirectional communication. Our work highlights that an efficient dialogue with faith-based communities can greatly enhance the results of public health interventions. As the outlined principles apply to a variety of contexts, the lessons learned from this case study can be generalized into a set of policy recommendations for the betterment of future public health initiatives worldwide.

Keywords: COVID-19, public health, religion, Romanian Orthodox Church, Romania, faith-based communities, religious institutions, religious leaders

INTRODUCTION

The COVID-19 pandemic created an unprecedented public health emergency. Across the world, the responses of governments varied in terms of effectiveness and timeliness. In many countries, healthcare systems became overwhelmed by the high number of infections and hospitalizations. Appropriate public health interventions such as social distancing, lockdowns, and self-isolation have proven effective in controlling the spread of the disease and the resurgence in cases before the implementation of mass-vaccination programmes (1, 2). During these times, efficient

communication from public health authorities became an essential criterion for both tackling misinformation about the pandemic and reducing social unrest caused by restrictive measures (3, 4). Moreover, when COVID-19 vaccination campaigns unfolded, accessing all available channels of communication became paramount for providing appropriate information to the public and thus achieving successful outcomes (5–7).

Public health interventions are reliant on various factors, including the nature of the implemented measures and the trust and compliance of the public. In the context of healthcare emergencies, the timeliness of the response is crucial, and this imposes additional challenges for achieving the desired outcomes (8–10). Importantly, emergency situations require efficient and extensive dialogue with the public. As such, reaching beyond the usual information channels during crisis situations can greatly facilitate the success of public health measures. These communication methods include mechanisms such as engaging non-governmental entities, influential public figures, and religious communities.

The involvement of religious institutions and faith-based organizations in public health campaigns is known to have a great potential for ensuring the success of such initiatives (11, 12). Furthermore, the influence of religious leaders within their communities is an essential factor for increasing public acceptance of such campaigns and delivering successful outcomes (13–16). Indeed, during the COVID-19 pandemic, recommendations for religious leaders and faith-based organizations were issued by the WHO and other healthcare agencies (17, 18). These guidelines mainly concerned the nature of religious gatherings, specific rituals, and important religious ceremonies in order to minimize the risk of disease transmission. However, few, if any, comprehensive guidelines were given to state authorities about how to engage religious institutions and organizations for the betterment of public health. Unfortunately, on many occasions, the absence of efficient dialogue resulted in mixed responses from religious communities, causing people to question or even directly oppose the implementation of official COVID-19 mitigation policies.

These issues were not only identified in highly religious countries, but they were also present in faith-based communities from more secular states. However, the negative effects were more pronounced in the former, where religious leaders and faith-based institutions have a much stronger influence on the wider population (19). In Europe, eastern countries stand out with an overall higher degree of religiosity, often coinciding with Orthodox Christianity as the predominant religious affiliation (20). With this in mind, recent data identify Romania as the most religious country in Europe, with more than half of its citizens being "highly religious" (20). Roughly 81.9% of Romanians are Orthodox Christians, 6.4% are Protestant Christians, 4.3% are Roman Catholic, and 1.1% are of other religions (Islam, Judaism, or other Christian denominations) (21).

As the established church of the country, the Romanian Orthodox Church (ROC) ranks second in terms of overall public trust, after the military (22, 23). As such, the responses of the ROC during the COVID-19 pandemic provide valuable insights into how a religious institution can contribute to public health efforts during a situation of crisis. In the following sections, we provide a descriptive analysis of the COVID-19 responses of the Romanian authorities and the ROC, emphasizing the importance of bidirectional communication during public health interventions. We argue that the absence of efficient dialogue can create misunderstandings which negatively influence the outcomes of the implemented measures. By contrast, if religious leaders and faith-based communities are involved in active consultations with state authorities, the effects of the implemented public health policies can be substantially enhanced.

CHURCH CONTRIBUTIONS TO THE MANAGEMENT OF COVID-19

Public Trust and Compliance During the Early Stages of the Pandemic

During the early days of the pandemic, Romania faced an unprecedented influx of members of its diaspora, which ranks among the largest in the world (23). To prevent an uncontrolled outbreak across the country, state authorities quickly implemented self-isolation and quarantine measures for people coming from abroad. The public perception of this situation was not favorable, especially when quarantine centers were opened in localities close to border crossing points. Returning Romanians were often vilified on social media platforms for importing infections into the country, and there were even protests outside quarantine centers, demanding the closure of these facilities (23). However, efficient communication from state authorities and the ROC mitigated the impact of these protests by increasing the understanding of the situation and advocating tolerance. Furthermore, high-ranking clergy of the ROC issued statements supporting the official guidelines, and some monasteries even provided quarantine spaces for people who were returning from abroad (24). These actions taken by the ROC during the early stages of the COVID-19 pandemic considerably bolstered the compliance of the public (23).

Orthodox Easter

In March 2020, the authorities implemented a national lockdown due to rapidly increasing numbers of COVID-19 cases in Romania (23). This raised concerns about how the upcoming celebrations of Orthodox Easter would proceed. On the one hand, public health experts warned about the risks of superspreading events, particularly during mass gatherings which are customary to the Easter service. On the other hand, clergy and church officials were concerned about the state interfering with religious freedom and the right to worship. This situation created a conflict which needed to be addressed promptly, as tensions were already high due to other restrictions such as mandatory face covering, social distancing, and the national lockdown. After extensive communication between state officials and representatives of the ROC, the Easter services were allowed to proceed without public attendance. The distribution of the

Holy Light to citizens' homes was performed by volunteers from local congregations, under the supervision and guidance of police officers and gendarmes. These extraordinary measures, only possible with the support of the ROC, were paramount to both preventing potential superspreading events and avoiding public unrest.

The following year, Orthodox Easter coincided with a period of epidemic decline and an increase in vaccination coverage (25). This led to an exception to the national curfew being granted for the public to attend the Easter service without any restrictions. Although this decision was welcomed by Orthodox believers and the ROC, it was met with criticism by various officials and public health experts. However, the Patriarchy issued guidelines for the safe officiation of the Easter service, including social distancing and other sanitary precautions that would limit the potential spread of infection (26). As in the previous year, these measures were the direct result of state authorities engaging in dialogue with representatives of the ROC. Consequently, contrary to the concerns that were voiced about the risk of allowing Easter services to proceed with full attendance, the average number of daily COVID-19 cases maintained a decreasing trend in the following weeks. An outcome similar to that of the previous Easter celebrations was achieved, although in a very different epidemiological context. In both situations, an efficient dialogue between state authorities and the ROC enabled the COVID-19 mitigation measures to be adapted to the current state of the pandemic, thereby greatly enhancing the overall outcomes of these public health actions.

Charitable Work

The contribution of the ROC to the management of the pandemic was not limited to endorsing and abiding by the official public health guidelines. Like other religious institutions worldwide, the ROC was involved in substantial charitable and philanthropic activities (27). In just 1 month after the first COVID-19 infections were detected in Romania, the ROC spent over one million USD in donations in order to help manage the impact of the pandemic (28). The ROC also donated medical devices and equipment to healthcare centers across the country. Moreover, in cooperation with regional and national authorities, faith-based organizations of the ROC created emergency hotlines to assist the medically and socially vulnerable. Together, the charitable activities of the Church have greatly contributed to mitigating the societal impacts of COVID-19 during all the stages of the pandemic.

Vaccination

In general, the official stance of the ROC toward vaccination is supportive, subject to individual rights being respected and an absence of commercial motivation (29). However, on many occasions, various faith-based organizations and highly influential figures of the ROC have opposed vaccination and have contributed to the spread of misinformation. As these activities were never officially condemned by the ROC, many religious leaders adopted a rather impartial stance on vaccination, probably because of its polarizing nature within their communities. Thus, there was an urgent need for issues concerning vaccine acceptance and misinformation to be addressed, even before the national COVID-19 vaccine rollout. Indeed, state authorities were aware that support from the ROC would have greatly benefited the national immunization campaign (27).

On 14 December 2020, before the approval of any COVID-19 vaccines, formal discussions took place between state officials, public health experts, and representatives of the major religions in Romania (30). It was agreed that health authorities would provide religious institutions with comprehensive information about COVID-19 vaccination. Several days after these discussions, the spokesperson of the ROC issued a statement in which a distanced and undecided stance was communicated on behalf of the Romanian Orthodox Patriarchate (31). However, dialogue continued between public health specialists and various representatives of the ROC, including the clergy. These activities used the already-established channels of communication with the ROC described in the examples above. Importantly, concerns about vaccination that were grounded in religious arguments were identified and addressed promptly with appropriate scientific information. As a result, religious leaders of the ROC and influential figures of local faith-based organizations were acclimatized to important concepts regarding COVID-19 vaccines and were given argumentative resources to combat misinformation.

Nearly 1 month after the meeting with the state authorities and the public health experts, religious representatives received informative materials about COVID-19 vaccination in the form of a comprehensive brochure (32). Shortly thereafter, the information was circulated to all clergy of the ROC alongside a statement from Patriarch Daniel of Romania. In this announcement, the national vaccination campaign was endorsed and the importance of verified and accessible sources of information about COVID-19 vaccines was emphasized (32). Furthermore, for the first time, a broadcast dedicated entirely to immunization was aired on the television channel of the ROC, where religious concerns about vaccines were addressed with scientific arguments (33). Subsequently, religious leaders and clergy of the ROC from across the country issued statements in favor of the national immunization campaign (27). As such, people were urged to trust the public health authorities and to use verified sources of information to answer questions about vaccination. Respectful consultation and cooperation thus enabled the vaccination campaign to use the extensive networks of the ROC for communicating public health information.

These actions were likely beneficial for the COVID-19 vaccination campaign, as the messages were able to reach a significant segment of the population. However, by October 2021, Romania had one of the lowest COVID-19 vaccination coverages and some of the highest COVID-associated mortalities in Europe (34). Furthermore, many voices within the ROC still actively opposed vaccination and religious arguments continued to be misused for discouraging vaccination. This phenomenon, however, can be explained by the high level of autonomy of the parishes, bishoprics, and archbishoprics within the ROC. Nonetheless, the overall support from the ROC was inadequate, and the fact that influential bishops did not vaccinate themselves

probably contributed to the persistence of mistrust toward COVID-19 vaccines (34). Although difficult to assess, engaging representatives of the ROC in active dialogues and consultations with state authorities from the earlier stages of the pandemic might have improved this situation. Indeed, the first public discussion on vaccination involving representatives of the major religions in Romania (including the ROC) took place as late as October 2021 and was organized by an online news agency (35). During the discussions, the lack of consultations regarding the implementation of COVID-19 public health policies was highlighted by all the religious representatives present. Such public dialogues would have likely improved the trust of faith-based communities in state authorities, thereby increasing COVID-19 vaccine acceptance of both clergy and believers.

THE IMPORTANCE OF BIDIRECTIONAL COMMUNICATION

Religious Gatherings and the Spread of COVID-19

In light of the measures that were implemented in Europe to limit the number of COVID-19 cases, religious institutions were faced with the difficult decision of whether or not to abide by the restrictions that often directly interfered with very important rituals and traditions (19). Although major religions generally supported the country-specific epidemic control measures, there were situations when these were challenged or not followed altogether by various religious communities. One of the most dramatic examples concerns the death of Patriarch Irinej of Serbia (36). He became infected with COVID-19 after officiating the funeral of Metropolitan Amfilohije of Montenegro, who succumbed to the same illness after holding religious ceremonies where public health guidelines were disregarded. In Romania, a similar scenario occurred when Archbishop Pimen passed away after being diagnosed with COVID-19. Pimen, the oldest member of the ROC synod, likely acquired the disease after coming into contact with infected staff or clergy from his archbishopric (37). Another possibility was also put forward after a video of him officiating the Easter service without respecting social distancing measures was released by the press (38). Regardless, his funeral attracted thousands of Christians and, contrary to the plea from the ROC that the social distancing measures should be respected, many people disregarded the official guidelines (37, 39).

Another dramatic situation concerning large gatherings of believers not abiding by social distancing and other epidemic control measures was at the pilgrimage of Saint Parascheva in 2020. In previous years, over the course of a few days, this event attracted close to 100,000 Orthodox Christians to the city of Iaşi, where the relics of the Saint are housed (40). This caused substantial pressure on state officials from both believers and clergy to allow the religious event to proceed. Consequently, the decision was made that the ceremonies would be permitted, but with participation restricted to the residents of Iaşi (41). Although this measure was intended to discourage traveling in order to limit the potential for COVID-19 transmission, people from all over Romania came to Iaşi to attend the religious services. There, unable to enter the premises of the cathedral where the ceremonies were taking place, large gatherings formed to protest the decision of the authorities (42). As a consequence of public pressure, the believers were eventually allowed entry to the relics of St Parascheva. This not only caused crowding at the pilgrimage site and an increased risk of transmission but also severely undermined the authority of the state officials. Despite the efforts of the ROC to implement sanitary measures (e.g., providing disinfectants) and enforce social distancing at the event, the failure of the authorities to control the flow of people negated all positive intentions to reduce the risk of infectious spread.

Throughout the COVID-19 pandemic, there were several other examples of pilgrimages where the official guidelines were not respected. Just as for the celebration of St Parascheva, the dialogue aimed at resolving potential issues was on many occasions non-existent, and government officials did not provide the necessary support to the ROC (43). As a result, attempts of the local authorities to enforce the COVID-19 measures were received with public outcries and protests. Such reluctance to abide by the control measures was generally grounded in the interpretation that the state is interfering with religious freedom (44).

State Policy Consequences on Religious Rituals

Public health policies in response to the COVID-19 pandemic often impacted the ways in which religious ceremonies were officiated. As such, practices that traditionally involved large gatherings of people, such as regular church services, baptisms, or weddings, were limited to a maximum number of attendants or were temporarily banned when the number of COVID-19 cases was high (45, 46). Similarly, funerals were limited to the immediate family of the deceased, and special precautions (e.g., sealed coffins) were taken to limit the potential spread of the virus. With this in mind, the ROC issued recommendations early on to the clergy about how to adapt religious practices to the new COVID-19 safety requirements (47). Furthermore, in addition to limiting the number of people attending church services, the ROC implemented further safety measures which were not yet mandated by the state (47, 48).

Although the COVID-19 mitigation efforts were generally endorsed by the ROC, there are several examples at different stages of the pandemic where successful outcomes were not achieved. For instance, ample discussions took place with regard to changing the religious practice of Communion so that single-use plasticware would replace the traditional chalice and spoon ordinarily used for this sacrament (49). Eastern Christian tradition, along with Christian tradition more widely, holds that the Church is most authentically itself when the faithful gather together in worship (50). Importantly, Communion is the highest expression and practice of the conjoint set of religious acts, where believers receive the body and blood of Christ, personified by bread and wine, respectively. The chalice and spoon, alongside other symbols, are all understood to be important aspects of communing with

God prayerfully and with one another faithfully. Important theological meaning thus underpins the statements made, the bodily gestures and postures enacted, and the ritualistic objects used.

From a public health perspective, several implications arise concerning Communion and the potential transmission of infectious agents (51). Firstly, large gatherings of people during any religious service may facilitate disease transmission. Secondly, the act of Communion involves proximal contact, as believers receive the sacrament from the priest. Moreover, Orthodox Christian tradition involves the shared use of the chalice and spoon among participating worshipers, without any disinfection during the ritual itself (52). Although there are no documented cases for disease transmission or outbreaks arising from partaking in Communion, scientific evidence suggests that infectious spread is possible (51). It is therefore understandable that concerns were raised regarding Communion during the early stages of the pandemic, especially as the infectious dynamics of COVID-19 were still unknown (53). However, the profound theological meaning of the act of Communion needed to be acknowledged if any public health policies were to directly or indirectly affect this religious practice.

In May 2020, a set of recommendations from the Romanian National Institute of Public Health (INSP) included measures to be implemented in places of worship. Importantly, the document contained the statement that "offering/receiving Holy Communion is to be avoided if disposable cups and spoons cannot be provided" (49). Although the purpose of this recommendation had a good justification given the potential for infectious transmission, it caused wide outrage among believers and clergy of the ROC. As Communion is central to Christian practice, many interpreted the guidelines issued by the INSP as the state interfering with freedom of religion (43). Moreover, a press release from the ROC stated that any decisions regarding Communion are to made exclusively by the Church and that the state should not interfere with the ways in which ceremonies are officiated (54). This example illustrates the importance of finding a common ground of discourse to address the implementation of public health interventions without causing profound theological disruptions. Indeed, many of the issues that occurred could have been avoided if the state authorities had initiated consultations with theologians and religious representatives.

Clergy Opposition to COVID-19 Guidelines

The failure of state authorities to provide a plan for how and when the restrictions would be relaxed sometimes contributed to the reluctance of faith-based communities to endorse and abide by the measures (55). This situation is substantially different to countries where a systematic approach to the ease of restrictions was provided to religious institutions, which was based on the national, regional, and local evolution of COVID-19 cases (19). For example, the UK government had issued detailed guidelines about how religious practices are to resume both during televised press conferences and on the government's dedicated website (56). At the same time, the implemented policies were continuously adapted to the evolution of the pandemic and were clearly communicated to the public. Together, these approaches greatly increased overall compliance, and the desired outcomes for public health were successfully achieved. As such, religious institutions were virtually back to normal routines by summer 2021, with pandemic mitigation measures mostly being implemented on a voluntary basis.

In Romania, although the ROC officially supported the COVID-19 mitigation policies, the absence of guidelines ensuring the safe continuation of religious practices created a wide range of issues. Indeed, an official statement from the ROC requested clarity about the conditions that would allow for a safe resumption of normal religious services (57). This absence of a systematic plan to relax restrictions had already caused outcry from various clerics throughout the country, including some prominent figures of the church. The most notable example is that of Archbishop Teodosie, who called upon believers to attend a second Easter service more than 1 month after the date of this central Orthodox holiday (58). As such, Christians were urged to attend the ceremony and not respect governmental COVID-19 guidelines. It is important to note that the ROC neither endorsed nor condemned this second Easter service officiated by Teodosie, citing the autonomy of archbishoprics which allows for such decisions to be made independently of the Patriarchy (59). Although state authorities condemned the actions of Teodosie, no official sanctions were implemented, neither for him nor for the people that disregarded public health measures.

Throughout the pandemic, Archbishop Teodosie became one of the major advocates against public health measures that directly or indirectly influenced religious practices in Romania. There were numerous instances when his defiance of national COVID-19 policies received ample media coverage (58). These included summoning Christians to pilgrimages when large gatherings were forbidden, disregarding social distancing measures during church services, and even propagating misinformation about the COVID-19 pandemic (58, 60, 61). The consequences of Teodosie's actions not only attracted criticism from public health experts, but they also eventually caused the ROC to publicly condemn his behavior. As such, the request of Teodosie to become Metropolitan was denied, partly on the grounds of his stances against the official position of the Church during various stages of the COVID-19 pandemic (62). Furthermore, the letter, which was leaked to the press, stated that his actions were "an act of rebellion" and also brought forward plagiarism charges which Teodosie faces at the university where he serves as head of faculty (62).

In general, the ROC tried to dissociate itself from the instances when clergy disregarded official COVID-19 guidelines, and publicly condemned such actions. However, the absence of any sanctions from state authorities against these members of the clergy most likely delayed any actions from the ROC. Indeed, public pressure alone was not sufficient to trigger disciplinary

measures against high-ranking clergy of the ROC. By contrast, continuous dialogue between state officials and the ROC would have most likely allowed for these issues to be addressed much more efficiently.

DISCUSSION

Religion is an important part of life for the majority of the Romanian population. We therefore analyzed the responses of the ROC to the COVID-19 pandemic and provided illustrative examples of the role of religious institutions during a major public health crisis. From the onset of the pandemic, the ROC supported national policies and encouraged the community to follow official guidelines. The ROC further introduced specific measures for adapting religious services and took an active stance against misinformation about both the pandemic and the national vaccination campaign. Furthermore, to assist those most affected by the pandemic, the ROC substantially increased its charitable activities. These actions, which significantly enhanced the national COVID-19 mitigation efforts, were enabled by efficient bidirectional communication between the Church and state authorities (43). By contrast, when dialogue was absent or insufficiently developed, the epidemic control measures were partly ineffective, and their potential to mitigate the spread of infection was not fully achieved.

Engaging faith-based communities for the improvement of public health is often challenging due to the complexities which arise from the implications of the implemented policies (11, 12, 46). The examples described in this paper reveal how active consultation between state authorities and religious institutions is paramount to achieving the desired goals. At the same time, we show that the failure to acknowledge potential religious consequences may lead to a diminished impact of the measures and to lower public compliance with official guidelines. The principles outlined herein extend to a variety of public health contexts, irrespective of country or religious belief. Therefore, we comprised several general policy recommendations which can be applied to improve the health of communities worldwide.

First, establishing clear guidelines is a necessary prerequisite for the success of any public health intervention. Public compliance and trust in healthcare authorities are both dependent on evidence-based policies that are implemented with transparency. As such interventions generally have consequences on multiple strata of society, an interdisciplinary approach is best suited to ensure that public health interventions have an enhanced impact. When religious communities are involved, this becomes particularly important due to any potential theological implications. Therefore, respectful consideration of any effects on religious practices both prior to and during the implementation phase may significantly increase the compliance of the public and maximize outcomes for public health.

Second, it is essential to develop efficient dialogue with religious institutions and faith-based communities. As a starting point, pre-existing channels of communication in various parts of society should be identified. These can lay the foundation for efficient streams of important and timely information. Concurrently, meaningful consultations with representatives of religious institutions during all stages of policy implementation can significantly bolster the effect of public health measures. Importantly, once established, these channels of communication with religious communities should not be restricted to the context of emergencies and can subsequently be harnessed for other public health initiatives.

Third, policy-makers should provide appropriate guidelines on how to safely resume religious practices. Transparency of the decision-making process and comprehensive information on the implemented measures are paramount. Importantly, the religious leaders and faith-based groups which they represent will require detailed explanations of the ongoing situation in non-specialist language. Such resources will then allow them to provide feedback about how the implemented measures impacted their communities. This will ensure higher compliance with the measures that directly or indirectly impact religious activities whilst also respecting the necessary health and safety requirements. Concurrently, if the feedback is considered in an appropriate manner, state authorities will be able to adapt the public health policies in order to maximize their effect.

Together, these approaches will enable religious institutions and faith-based communities to contribute toward shared goals during all stages of public health policy implementation. Moreover, effective communication will prevent avoidable disruptions to individual freedoms, thereby resulting in even higher levels of public compliance. Synergistic effects can thus be achieved which can substantially increase the benefit for society and public health.

CONCLUSION

The lessons learned from the involvement of the ROC throughout the COVID-19 pandemic demonstrate the importance of efficient bidirectional communication with faith-based institutions for the betterment of public health. At the same time, they illustrate both the main challenges in engaging religious institutions and the best approaches for reaching shared goals. Importantly, this case study reveals general principles of the interactions between governmental bodies and faith-based communities regarding the implementation of public health policies. The examples provided clearly highlight the mutual benefit of dialogue when public health measures impact on religious practices. Furthermore, they serve as a basis for the outlined policy recommendations, which readily apply to a variety of public health contexts. Indeed, through respectful consultations and comprehensive discussions with representatives of faith-based communities, the outcomes of

many public health initiatives could be greatly enhanced 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

SD was involved in public health efforts in Romania and acted as an external intermediary between state authorities and religious representatives on several occasions throughout the COVID-19 pandemic. SD and MB coordinated the academic initiative underlying this work. All authors contributed to the writing of the manuscript.

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Socio-Demographic Characteristics of COVID-19 Vaccine Recipients in Kwara State, North Central Nigeria

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Understanding key socio-demographic variables of 2019 coronavirus disease (COVID-19) vaccine recipients is crucial to improving its acceptance and Nigeria's COVID-19 control strategy. The survey was conducted as a non-probability cross-sectional survey of 2,936 COVID-19 vaccine recipients in Kwara State. Our findings revealed that 74% (n = 2,161) of the vaccine recipients were older than 40 years. Forty percent (n = 1,180) of the vaccine recipients earned a monthly income >100,000 Naira (equivalent to US $200). Most of the vaccine recipients (64%, n = 1,880) had tertiary education, while 15% (n = 440) of them had no formal education. Almost half of the recipients (47%, n = 1,262) were government employees and 28.8% (n = 846) of them had health-related backgrounds. Only 17% (n = 499) of the vaccine recipients have been screened for the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), of which 21% (n = 105/499) of them were tested positive. Only 47% (n = 1,378) had been fully immunized. The prevalence of confirmed COVID-19 cases among COVID-19 vaccine recipients in Kwara State was 3.6% (n = 105/2,936). The most recurrent adverse events following immunization (AEFIs) among vaccine recipients were fever (14%, n = 411), pain at injection site (47%, n = 1,409), headache (19%, n = 558), and body weakness (9%, n = 264). The need to protect themselves from the deadly virus was the main reason that prompted people to voluntarily accept the COVID-19 vaccine. There is a high level of COVID-19 vaccine acceptance among respondents across all social classes including those with no formal education, those with very low monthly income (<US $2 per day), and in untested population. Hence, vaccine donors should prioritize equitable distribution to Low-and-Middle-income Countries (LMICs) such as Nigeria, and health authorities should improve vaccine advocacy to focus on vaccine safety and efficacy.

Keywords: COVID-19, vaccine acceptance, Nigeria, vaccine recipients, socio-demographic

INTRODUCTION

The 2019 coronavirus disease (COVID-19) has caused a serious global public health crisis. The pandemic also has severe socio-economic impacts resulting from international travel ban and movement restrictions (1). To curb its spread, several non-pharmaceutical interventions (such as the banning of international flights, use of nose masks, frequent handwashing, social distancing, and mandatory stay-at-home order) were instituted (1–3). However, the world needed vaccines to protect lives, restore the economy, and return to the "new normal" (4). Generally, vaccinations are safe and effective in boosting the host immunity before the host comes in contact with the wild-type pathogen (4).

As of August 31, 2021, more than 215 million confirmed COVID-19 cases and over 4.48 million deaths have been recorded in over 200 countries and some 4.6 billion doses of the COVID-19 vaccine have been administered (5, 6). Nigeria (with over 210 million inhabitants) has recorded 190,118 COVID-19 cases and 2,244 deaths from which Kwara State (with a population of 3.6 million) has recorded 3,513 confirmed COVID-19 cases (1.8% of Nigeria's COVID-19 cases) and 55 COVID-19-related deaths as of August 27, 2021 (7).

Nigeria received the first COVID-19 vaccine (4 million doses of the Oxford-AstraZeneca vaccine) in March 2021, out of which Kwara State received 55,790 doses of the vaccine in March and finished administering the vaccine in July 2021 (8, 9). This volume of vaccine is grossly inadequate for its 3.6 million inhabitants and might have very little impact in halting the spread of the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) in the state.

The arrival of the second batch of COVID-19 vaccines (4 million doses of Moderna COVID-19 vaccine and 177,000 doses of the Johnson and Johnson COVID-19 vaccine) necessitates the urgent socio-demographic understanding of the COVID-19 vaccine recipients (10, 11). This will enable public health officials and policymakers to adopt the most effective health communication strategies necessary to increase the public acceptance of the COVID-19 vaccines.

Several studies have assessed and modeled the potential acceptance of the COVID-19 vaccines in Nigeria, Africa, and in some Low-and-Middle-income Countries (LMICs) (12–17). However, there is a dearth of information if these potential acceptance rates and campaigns translated actual acceptance of the vaccines.

Understanding the community-level vaccine acceptance dynamics is important to prevent a lag in vaccination in any cluster (community or zone); a condition that could prompt or promote the emergence and spread of vaccine-induced (resistant) variants (18, 19). This is the first study that provides a locally focused picture of COVID-19 vaccine recipients in Nigeria. We moved beyond potential vaccine acceptance rates to collecting and analyzing data aimed at understanding who took the vaccines and their reasons for accepting the vaccine.

Hence, this study presents the descriptive statistics of the COVID-19 vaccine recipients in Kwara State and provides information to guide public health decision-makers in Kwara state and the country at large.

METHODS

Ethical Approval

The ethical clearance of this study was obtained from the Kwara State Ministry of Health, Ilorin, Nigeria (Reference number: MOH/KS/EHC/777/502). Written informed consent was obtained from each respondent after brief information on the purpose of the study was provided to them. The respondents either signed the paper questionnaire or ticked the box in the mobile application [open data kit (ODK)]. Participation in this survey was voluntary and without prejudice as specified in the World Medical Association Declaration of Helsinki Ethical principles (20).

Study Design, Study Participants, and Sampling

This study was designed as a cross-sectional survey of adult respondents (18 years and above) from the three senatorial zones of Kwara State. The state has a human population of ∼3.6 million people (21). The survey started on July 11 to 20, 2021. The study was conducted as a one-on-one interview at the designated COVID-19 vaccination centers across the state. Vaccination centers ($n = 70$) were strategically spread across the state (in each of the 16 local government areas of the state) by the Kwara State Primary Health Care Development Agency (Kwara PHCDA).

Survey Methodology

The study was administered as one-on-one interviews to vaccine recipients from selected COVID-19 vaccination centers across the state using a multi-stage sampling technique (**Supplementary Table 1**). Three local government authorities (LGAs) were selected by simple random sampling technique from each senatorial zone of the state (a total of 9 LGAs). Furthermore, three (3) COVID-19 vaccination centers were selected from each of the LGAs. Data collectors were trained on the methodology of the survey and were sent to pre-selected vaccination centers in their respective LGA. Each respondent was interviewed independently to prevent clustering of responses. The questionnaire (in English or verbally translated to the respondents' languages where necessary) was administered while the vaccine recipients waited to be registered or inoculated with the vaccine. Each vaccine recipient was selected by systematic random sampling with a sampling frame of two. Hence, we sampled the first, fourth, seventh person and so on. However, in certain vaccination centers with few vaccine recipients (<10), we sampled all of them.

With an estimated population of 3.6 million people in the state, at a 96% confidence interval, assuming a 50% vaccine acceptance rate, and a 4% margin of error, the required sample size is 849 vaccine recipients per senatorial zone. Hence, we calculated at least 2,547 individuals were needed. Eventually, the survey instrument was administered to 2,936 COVID-19 vaccine recipients across the three senatorial zones (9 LGAs and 27 vaccination centers) of the state. Of these, 1,174 (40%) were from Kwara Central, while other respondents were equally distributed between Kwara North and Kwara South (881 respondents, respectively).

Questionnaire Design

A structured questionnaire was developed for this study and administered as paper questionnaires or through the ODKs on mobile phones to obtain information from vaccine recipients. The choice of both paper and ODK questionnaire was based on the availability of android phones to some data collectors. Two independent reviewers were selected to validate the questionnaire to assess the content validity, clarity, ease of response, scope, and the face validity of the questions. Furthermore, the Cronbach alpha test was used to assess the reliability of the survey instrument (with a score of 0.7). Finally, to check for technical glitches, the aptness of the survey tool, and typographical errors, a pre-test of the survey was administered to 10 vaccine recipients from each of the 27 selected vaccination centers. Responses obtained from the pre-test were not incorporated in the final analysis of the data. The survey instrument had only two sections: A and B. Section A assessed the demographic characteristics of the respondents (age, gender, level of education, monthly income, occupation, background, and marital status), while Section B focused on the COVID-19 vaccine (**Supplementary File 1**).

Data Analysis

The data were summarized using Microsoft Excel (Microsoft, Redmond, WA, USA) and subjected to further statistical analysis using Minitab v.17 (Pennsylvania, USA). Qualitative data were presented as frequencies and proportions.

RESULTS

Demographics of COVID-19 Vaccine Recipients in Kwara State

Our findings revealed that all age groups received the vaccine. However, persons older than 40 years represented 74% of the total respondents. Forty percent (n = 1,180) of the vaccine recipients earned a monthly income >100,000 Naira (equivalent to US $200). Most of the vaccine recipients (64%, n = 1,880) had tertiary education, while 15% (n = 440) of them had no formal education (**Table 1**). Almost half of the recipients (47%, n = 1,262) were government employees from the civil service, academia, government teachers, military, para-military, and retirees. Only 846 (28.8) of the vaccine recipients had health-related backgrounds (medical sciences, medical laboratory scientists, community health workers, nurses, etc.). Most of the vaccine recipients (80%, n = 2,349) were married.

Our survey showed that only 499 (17%) of the vaccine recipients have been screened for the SARS-CoV-2. Of the 499 persons previously screened for the SARS-COV-2, 105 (21%) of them were tested positive for SARS-CoV-2 (**Table 2**). Hence, the prevalence of confirmed COVID-19 cases among COVID-19 vaccine recipients in Kwara State was 3.6% (n = 105/2,936). Of the 2,936 vaccine recipients included in this survey, only 1,378 had been fully immunized (taken the two doses of the Oxford-AstraZeneca vaccine). The most recurrent adverse event following immunization (AEFI) among vaccine recipients (from second dose recipients only) were fever (30%, n = 411), pain at injection site (87%, n = 1,198), headache (40%, n = 558), and body weakness (19%, n = 264). The need to protect themselves from the deadly virus was the main reason that prompted people to voluntarily accept the COVID-19 vaccine.

TABLE 1 | Socio-demographic profiles of 2019 coronavirus disease (COVID-19) vaccine recipients in Kwara State (n = 2,936).

Variable	Frequency (%)
Age (Years)	
18–29	352 (12)
30–39	423 (14.4)
40–49	752 (25.6)
50–59	681 (23.2)
>60	728 (24.8)
Gender	
Female	1,174 (40)
Male	1,762 (60)
Monthly income	
30,000 or less	629 (21.4)
30,000 – 100,000	1,127 (38.4)
>100,000	1,180 (40.2)
Level of education	
No formal education	440 (15)
Primary education	264 (9)
Secondary education	352 (12)
Tertiary education	1,880 (64)
Occupation	
Government employee	1,262 (43)
Private company or self-employed	1,673 (57)
Background	
Health-related	846 (28.8)
Non-health related	2,090 (71.2)
Marital status	
Single	446 (15.2)
Married	2,349 (80)
Divorced/Widowed	141 (4.8)

More vaccine recipients have been screened in Kwara Central than in the other two senatorial zones. However, there were no statistically significant differences in the demographics of the vaccine recipients from the three senatorial zones. Most vaccine recipients (89%, n = 2,613/2,936) across the state voluntarily accepted the vaccine because of their need to protect themselves as well as others around them.

DISCUSSION

Vaccinations are one of the greatest public health interventions against infectious diseases (22). Hence, the acceptance of the COVID-19 vaccine is as important as its availability and equitable distribution, especially in resource-limited settings. Our study contributes to the emerging picture on COVID-19 vaccine acceptance by focusing on data obtained from 2,936 vaccine recipients across 45 vaccination centers across Kwara State.

There are five main individual determinants for vaccine acceptance: confidence, complacency, convenience, risk calculation, and collective responsibility (23, 24). These

TABLE 2 | Responses related to COVID-19 vaccine in Kwara State ($n = 2,936$).

Variable	Frequency (%)
1a. Prior screening for the SARS-CoV-2?	
No	2,437 (83)
Yes	499 (17)
1b. Result of SARS-CoV-2 screening test*	
No	394 (79)
Yes	105 (21)
2. Dose of vaccine	
1st dose	1,558 (53)
2nd dose	1,378 (47)
3. Known underlying condition	
No	2,730 (93%)
Yes	206 (7%)
4. Adverse events following your inoculation with the COVID-19 vaccine	
No	843 (28.7)
Yes	2,093 (71.3)

determinants have made Nigerians accept the COVID-19 vaccines despite concerns about vaccine safety and efficacy especially with the rapid pace of COVID-19 vaccine development, reports of thrombosis associated with the Oxford-AstraZeneca COVID-19 vaccine, consistently low COVID-19 cases and deaths in Nigeria, poor perception of COVID-19 severity, mistrust in government's handling of the pandemic, lack of economic palliatives for citizens, and poor healthcare infrastructure (25, 26).

Consistent with previous findings, our findings revealed higher vaccine recipients among men than women (15, 27). We advocate that community engagement activities involving social learning and women groups could help increase vaccination acceptance among women using the Social and Behavioral Change Communication (SBCC) approach. This will persuade more women to accept the vaccine.

Although more than half of the vaccine recipients ($n = 1,880$) had tertiary education, our findings showed that about a quarter of the recipients ($n = 704$) had no formal education or just went through basic school. In the same vein, 21% of the vaccine recipients included in this study earned the minimum wage (monthly income of 30,000 Naira or US $59) also voluntarily accepted the vaccine. It is encouraging to know that these sub-populations voluntarily presented themselves for the COVID-19 inoculation. So, we believe that the general public will adopt and comply with the non-pharmaceutical intervention guidelines (frequent handwashing, use of face masks, social distancing, cough etiquette, etc.) if the government re-strategize its mass COVID-19 advocacy campaigns.

There were no statistically significant differences in the demographics of the vaccine recipients from the three senatorial zones. However, more persons have been screened for SARS-CoV-2 in Kwara Central than in the other two zones. This could be because the only COVID-19 testing center is located in Kwara Central. However, there are designated sample collection points in every local government of the state. Hence, the health authorities should provide at least a COVID-19 screening facility in each of the senatorial zones.

Consistent with other reports, Nigeria (Kwara State included) must improve its COVID-19 testing capacity (including molecular genomic surveillance) (25, 28, 29). This poor COVID-19 testing mechanism is evident in that of the 2,936 vaccine recipients included in this study, only 499 (17%) of them have been tested for the SARS-CoV-2. The poor testing rate could be due to the stigma associated with COVID-19 especially at the rural level []. This has made people shy away from testing. However, with the arrival of the vaccine (the anticipated cure), people voluntarily presented themselves for inoculation even at the grass-root level.

With a prevalence of 3.6% in the tested sub-population, health agencies must ensure that statewide or nationwide screening for SARS-CoV-2 is intensified to determine the true prevalence of COVID-19. This will help identify positive predictors, predisposing factors, and clusters of infections across the state and the country (25).

The self-reported AEFI recorded in the 1,378 fully immunized persons were transient side effects (pain at the injection site, headache, fever, fatigue, etc.). This is consistent with several reports that COVID-19 vaccines were safe (30–34). Contrary to the wildly circulated magnetic theory of the COVID-19 vaccine (35, 36), none of the recipients reported being magnetic. This shows that the vaccine is safe and effective to reduce hospitalizations and the tendency of spreading the disease (15–17).

Another major focus of this study was to understand what prompted vaccine recipients to voluntarily accept the vaccine despite long queues and hassles in the vaccination centers. We found that the need to protect oneself from deadly diseases and prevent complications of underlying disease conditions (co-morbidities) were the most prominent reasons for accepting the COVID-19 vaccine among our study participants. This is similar to the report of Solis-Arce et al. (27).

To further boost the vaccination acceptance among Nigerians, health agencies should adopt the WHO's Behavioral and Social Drivers of Vaccination model (BeSD) which suggests that countries should reduce access barriers to COVID vaccinations (37). Dependent on the availability of vaccines, health authorities should make vaccines closer to the populace by increasing vaccination centers across the state, reducing the time lag in the online registration of recipients, and designing integrated health programs that will leverage on the vaccination centers' workforce and facilities.

The implications of our findings for public health were that there is a high level of vaccine acceptance among respondents with no formal educations, those with very low monthly income (<US $2 per day), and in the untested population than initially anticipated. This should encourage vaccine donors to prioritize equitable distribution to LMICs such as Nigeria as with the constantly increasing population of LMICs, the world could in a short time attain herd immunity (27).

The main strength of this study is its large sample size, the timeliness of the study before the second phase of the COVID-19 vaccination in Nigeria, and its widespread participants across the study area. However, the main limitation is that our data might not be representative of all COVID-19 vaccine recipients in the state ($n = 57{,}790$).

In Nigeria, an increased vaccine acceptance rate can be achieved by persuading the populace through community engagement activities and employing SBCC strategies. We advocate that vaccine messaging should focus on vaccine safety, efficacy, and the lack of side effects even in persons with co-morbidities. While some studies have reported that cash tokens or in-kind incentives have increased vaccination rate especially in childhood immunization programs in several LMICs (37–41), this study observes a positive attitude of vaccine recipients, and we opine that vaccination date reminders and few logistic improvements would suffice and no cash incentives are needed yet.

CONCLUSION

This study provided socio-demographic information on COVID-19 vaccine recipients across Kwara State. There was high vaccination acceptance among all social classes. Increased vaccine acceptance can be achieved using the community engagement approach with an emphasis on vaccine safety and efficacy.

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 Review Board of the Kwara State Ministry of Health, Ilorin, Nigeria (Reference number: MOH/KS/EHC/777/502). The participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

All authors contributed equally to the conception, analysis, and writing 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.2021.773998/full#supplementary-material

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Changes in Alcohol Consumption and Determinants of Excessive Drinking During the COVID-19 Lockdown in the Slovak Republic

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As a result of the coronavirus disease 2019 (COVID-19) pandemic, countries have been forced to adopt strong restrictions, such as lockdown, which can lead to serious consequences for public health, including the problematic use of addictive substances. The aim of this cross-sectional study was to examine changes in alcohol consumption and to identify determinants against the background of excessive drinking during the COVID-19 lockdown in the Slovak Republic. The research included 445 respondents (33% males and 67% females), and the data collection through the questionnaire took place from April 29, 2020 to July 1, 2020. Measures such as drinking frequency, amount of alcohol and excessive drinking were used to examine alcohol consumption. Descriptive analysis and binary logistic regression were used to meet the main aim. The findings provide a closer look at the situation in the Slovak Republic and contribute to comprehensive international knowledge. The frequency of excessive drinking did not change in about half of respondents (53% of males and 69% of females). More respondents decreased their excessive drinking than increased, both among males (31 and 16%, respectively) and females (25 and 6%, respectively). Similar results were found for drinking frequency and amount of alcohol. Amongst Slovak respondents, an increase in excessive drinking was more common among males, younger people, smokers, and smokers who increased smoking during the lockdown. Especially in the case of vulnerable populations, public policies should consider a response to impending problems. The findings of this study encourage the implementation of effective and evidence-based prevention programs, which are more than necessary in the Slovak Republic.

Keywords: alcohol consumption, drinking, unhealthy behavior, determinants, individual characteristics, substance use, COVID-19 lockdown, Slovakia

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INTRODUCTION

The world has been hit by severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2), which has led to hitherto unknown conditions in people's lives. In this context, many countries have established strict measures that have been reflected in social life. These measures were associated with restrictions, quarantine and isolation aimed at defeating the coronavirus disease 2019

(COVID-19) pandemic. It was not possible to observe another situation in the Slovak Republic. People began to face threats such as unknown disease, job loss, limitations in education and opportunities, but also economic recession, and all these aspects could lead to risky behavior (1). Thus, the COVID-19 pandemic can be characterized as a mass trauma with health consequences, including addictive problems. This fact was emphasized by Da et al. (2), who found that social isolation can lead to psychological decompensation and increased alcohol consumption or relapse. The increase in alcohol relapse, but also newly diagnosed individuals with alcohol use disorder and alcohol-related liver disease, may be a result of the phenomena of social isolation. Also, Rehm et al. (3) noted that monitoring alcohol consumption levels during and after the COVID-19 pandemic is necessary to better understand the effects of COVID-19 on alcohol abuse. These facts were the greatest motivation for an international team of researchers who decided at the beginning of the pandemic to examine patterns of unhealthy behavior in 22 European countries. This spectacular effort revealed valuable findings in a sample of 40,064 respondents (4–6), and the presented study is a part of this European research effort.

Increasing alcohol consumption and alcohol-related negative consequences for human health were a major problem in the Slovak Republic even before the pandemic (7). This is evidenced by the fact that the Slovak Republic is one of the countries with the highest levels of alcohol consumption in Europe, while the reason may be easier accessibility of alcoholic beverages, especially during social events and entertainment (7, 8). Alcohol consumption in the Slovak Republic is and has been a common habit of everyday life, while alcohol not only has a calming and relaxing effect on Slovaks, but also causes social and health suffering (9). In this context, the Slovak population in the pre-pandemic period was at risk of alcohol-related diseases and mortality across regions, as well as gender and age groups (10, 11). Different levels of normative (descriptive and injunctive) beliefs prevailed in the Slovak population, influencing the relationship between attitude toward alcohol consumption and individual frequency of alcohol consumption (12). Brutovska et al. (12) revealed that a more positive attitude toward alcohol use, male gender and higher income were associated with more frequent alcohol consumption among young Slovak adults. For these reasons, it is desirable to know a situation in this country during the COVID-19 pandemic. At this point, it should be noted that the lack of scientific and political attention is being paid to the alcohol problems in this country. In addition, similar research has not yet taken place during the pandemic in the Slovak Republic.

In any case, there is evidence from China that during the outbreak of severe acute respiratory syndrome (SARS) in 2003, the symptoms of alcohol abuse and addiction in healthcare workers were associated with quarantine and work in a high-risk location, with people using alcohol as a coping strategy (13). On this basis, there is a need to monitor drinking behavior as well as its determinants against the background of the current COVID-19 pandemic in each country, including the Slovak Republic. In general, excessive drinking is well examined in many countries, but there is a lack of scientific studies in the Slovak Republic addressing this serious problem. Changes in alcohol-related behaviors are inconsistent across countries and their populations, with some individuals reporting an increase in alcohol consumption and others reporting a decrease. Therefore, it is justified to investigate this problem.

The COVID-19 pandemic is an unprecedented phenomenon that requires research in different areas of people's lives in individual countries, including alcohol-related problems. To successfully overcome the consequences of the pandemic, it is essential to know the current situation and the main determinants of health risk behavior in society, as well as vulnerable population groups. This allows for early monitoring and addressing of possible future problems in the field of addictology. For these reasons, the presented study focuses on changes in alcohol consumption and determinants of excessive drinking during the COVID-19 lockdown in the Slovak Republic, filling a research gap in this country. Understanding the problem is especially important for the development of successful strategies and programs aimed at reducing alcohol consumption. Despite the fact that alcohol consumption and its determinants is a well-examined problem around the world, the Slovak Republic is a country that has long neglected and overlooked this threat in society. Insufficiency can be observed not only in the research area, but also at the level of implementation of prevention policies targeted at reducing alcohol consumption in the population. This is reflected in the lack of evidence-based interventions. That is why research is needed in this region. Understanding the situation is especially important during and after the COVID-19 pandemic for the development of successful strategies and programs. The study provides a valuable platform for information on changes in the frequency of alcohol consumption and significant determinants of excessive drinking, which are a key pillar of decision-making by Slovak leaders in the field of public health. Without sufficient evidence, it is not possible to design and implement effective programs that are lacking in this country.

MATERIALS AND METHODS

This study is attributed to the efforts of an international research team from 22 European countries to investigate alcohol-related behavioral patterns at the beginning of the COVID-19 pandemic. The survey was conducted in English and was translated into different languages through an international network of researchers. This project was largely covered by the commitment of the European Study Group on Alcohol use and COVID-19. In total, 40,064 respondents were included in the international survey and it is an honor of the authors of this study to present findings from the Slovak Republic. The study contributes to the valuable findings of studies already conducted based on these unique international data (4–6).

Research Aim and Questions

The findings presented in the introduction underline the importance of examining various aspects of excessive alcohol consumption during the COVID-19 pandemic, as public policy makers in each country should know the evidence-based

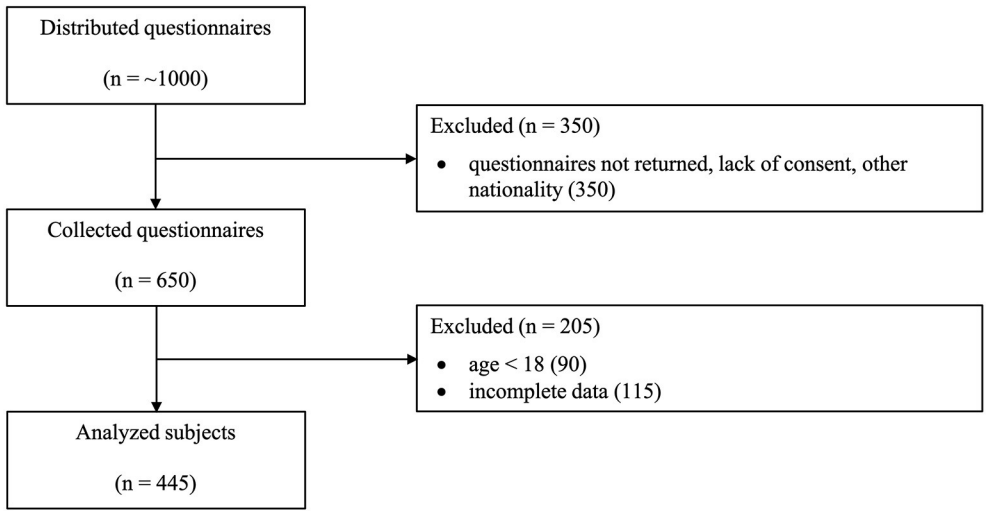

FIGURE 1 | Selection process of respondents to obtain the research sample.

information for implementing effective strategies. Therefore, the aim of this study was to examine changes in alcohol consumption and to identify determinants against the background of excessive drinking during the COVID-19 lockdown in the Slovak Republic. Following this aim, two research questions were formulated:

- RQ1: Did the Slovak respondents report changes in alcohol consumption during the COVID-19 lockdown?
- RQ2: What are the determinants of excessive alcohol consumption during the COVID-19 lockdown in the Slovak Republic?

Data

Data were collected using an online questionnaire in 22 European countries in collaboration with a group of international researchers. The questionnaire aimed to reveal information about the relationship between the COVID-19 pandemic and changes in consumption of tobacco, alcohol, cannabis and other illegal drugs in European countries. The questionnaire also collected various socio-demographic information about respondents. This study presents only data for the Slovak Republic, which were collected during the lockdown in the Slovak Republic, which started in the second week of March 2020. Data for the Slovak Republic were collected between April 29, 2020 and July 1, 2020, thus more than 1 month after the outbreak and at the end of the first wave. The respondents were contacted on social networks, and the second form of data collection was direct messages and e-mails requesting the completion of the questionnaire. The respondents did not receive any financial reward and no paid promotion was used. A total of 445 respondents were included in the final research sample. The process of selecting respondents to obtain the final research sample is shown in **Figure 1**. The selection criteria were approved consent, Slovak nationality, age over 18 years and complete responses.

As indicated, the questionnaire focused on detection of changes in alcohol, tobacco and illegal drug use. However, in this study, attention was focused on changes in alcohol consumption during the lockdown in the Slovak Republic. The research included three questions from the questionnaire, which were proposed by the European team and formulated in the same way for all countries. The questions were formulated as follows:

- Did you drink alcohol less or more often in the past month?
- Did the amount of alcohol you usually drink on each drinking occasion change in the past month?
- Did the frequency of drinking occasions where you drank a high amount of alcohol (i.e., 6 or more drinks) change in the past month?

Based on the initial European effort, the first question focused on changes in drinking frequency, the second question focused on changes in amount of alcohol, and the third question focused on extreme rate of drinking behavior during the lockdown. These three questions offered possible responses using the Likert scale as follows: 1–much less, 2–slightly less, 3–no change, 4–slightly more, 5–much more.

Governance and Ethics

The survey was completely anonymous and personal data were protected in accordance with the European Union Regulation 2016/679 of the European Parliament and Council, which facilitates ethical assessment. The research was approved by the ethics committee of the Clinical Trials Services, USP TECHNICOM, Technical University of Košice, Slovakia (Ref. 02/04/2021 IG Bioinformatics). All respondents included in this study received the same information about the research and confirmed their informed consent at the beginning of the questionnaire. The respondents did not receive any financial reward. All aspects in this research were conducted with respect to the seventh revision of the World Medical Association–Declaration of Helsinki (14) and the second revision of the Farmington Consensus (15).

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Statistical Approach

In order to meet the main aim of this study and to answer the research questions, the following statistical approach was chosen. First, a descriptive analysis was provided to present the distribution of the respondents' answers according to gender classification, as well as to identify changes in drinking during the COVID-19 lockdown in the Slovak Republic. This also helps to take a first look at the data. Subsequently, a binary logistic regression was used, in which the dependent variable was the answer to the third question "Did the frequency of drinking occasions where you drank a high amount of alcohol (i.e., 6 or more drinks) change in the past month?" This question was predefined and designed by the European research team led by J. Rehm and was considered an extreme rate of alcohol drinking during the lockdown. Strict measures and interventions were established during the lockdown to defeat COVID-19, and it was therefore interesting to examine the selected question. This provided findings on excessive drinking in the context of the COVID-19 pandemic and related interventions, especially in public life. Other questions from the questionnaire were also examined and the findings will be published separately. Excessive alcohol drinking is a harmful behavior for physical (16) and mental health and is considered a serious social problem, especially in critical situations, such as the COVID-19 pandemic. Adrian and Barry (17) showed that individuals with excessive drinking have a higher morbidity rate for mental disorders. Skinner and Allen (18) found that alcohol abuse has social consequences, even though alcohol is a socially acceptable drug, and is associated with thinking disorders, anxiety, depression, as well as physical symptoms of the cardiovascular, nervous, and digestive systems. As there were five possible answers and the logistic regression uses only a dichotomous variable, the answers "slightly more" and "much more" were included in the first category called "MORE," and the answers "slightly less," "much less" and "no change" were included in the second category called "LESS + NO CHANGE."

The main objective of the performed analysis was to observe changes in alcohol consumption, considering various socio-demographic characteristics of individuals. Backward stepwise regression was used, meaning that the estimation in this study started with all potential explanatory variables in the model, assuming that they could have an impact on excessive drinking during the COVID-19 lockdown. Specifically, the following variables were initially considered in the regression: gender, age, income, changes in income, education, residence, household size, changes in public life caused by the spread of COVID-19, changes in private life caused by the spread of COVID-19, negative consequences in occupational or financial situation due to the spread of COVID-19, smoking, changes in smoking behavior, changes in cannabis use, changes in illegal substance use. The categorization used for these potential explanatory variables is provided in **Supplementary Table 1**. Subsequently, statistically insignificant variables were sequentially dropped from the model in order to obtain a parsimonious model with only statistically significant variables. Changes in Log Likelihood were used as threshold selection criteria for backward elimination.

Binary logistic regression overcomes restrictive assumptions of linear regression. When using binary logistic regression, the dependent variable does not have to come from a normal distribution. Furthermore, this method does not require a linear relationship between the dependent variable and the regressors. Even if the residues must be independent, they do not have to be distributed normally. The only assumption that needs to be met is the assumption of the absence of multicollinearity among explanatory variables, which was fulfilled in this study.

In the regression model, the examination was focused on the occurrence of the frequency of drinking occasions where the respondent drank a high amount of alcohol (i.e., 6 or more drinks) during the lockdown due to COVID-19, thus the occurrence of excessive alcohol consumption. The regression model formula was as follows:

$$\ln\left(\frac{\Pr\left(excessive\ drinking = MORE\right)}{\Pr\left(excessive\ drining = LESS + NO\ CHANGE\right)}\right) = \beta_0 + \sum_{i=1}^{n} \beta_i \times x_i$$

where ln (excessive drinking = MORE) describes a probability with which the dependent variable is "MORE," while a probability of "LESS+NO CHANGE" value is: Pr (excessive drinking = LESS+NO CHANGE) = 1–Pr (excessive drinking = MORE). The expression $ln\left(\frac{Pr(excessive\ drinking=MORE)}{Pr(excessive\ drining=LESS+NO\ CHANGE)}\right)$ is marked as odds or a probability that a respondent drank excessively to a probability that respondent has not and its logarithm is marked as logit. β_0 is a constant in the model, β_i denotes the estimated regression coefficients, and x_i is the set of explanatory variables described above. Mathematical editing of the expression of the first equation above resulted in allocation probability to the first group, thus excessive drinking=MORE; and its equation has the following form:

$$Pr(excessive\ drinking = MORE) = \frac{1}{1 + e^{-(\beta_0 + \sum_{i=1}^{n} \beta_i \times x_i)}}$$

As mentioned above, the dependent variable was excessive drinking of alcohol during the COVID-19 lockdown. The dependent variable acquired a value of 1 if the frequency of drinking occasions where the respondent drank a high amount of alcohol (i.e., 6 or more drinks) increased and a value of 0 if it remained unchanged or decreased.

The analytical processing was performed in SPSS v. 19 (IBM, Inc., Armonk, NY, US).

TABLE 1 | Distribution of answers: frequency of drinking.

		Gender			
		Males		Females	
		Count	Percentage	Count	Percentage
Did you drink alcohol less or more often in the past month?	Much less	34	23.1%	56	18.8%
	Slightly less	17	11.6%	32	10.7%
	No change	60	40.8%	169	56.7%
	Slightly more	25	17.0%	34	11.4%
	Much more	11	7.5%	7	2.3%

TABLE 2 | Distribution of answers: amount of alcohol.

		Gender			
		Males		Females	
		Count	Percentage	Count	Percentage
Did the amount of alcohol you usually drink on each drinking occasion change in the past month?	Much less	29	19.7%	41	13.8%
	Slightly less	18	12.2%	26	8.7%
	No change	74	50.3%	205	68.8%
	Slightly more	20	13.6%	22	7.4%
	Much more	6	4.1%	4	1.3%

TABLE 3 | Distribution of answers: excessive drinking.

		Gender			
		Males		Females	
		Count	Percentage	Count	Percentage
Did the frequency of drinking occasions where you drank a high amount of alcohol (i.e., 6 or more drinks) change in the past month?	Much less	28	19.0%	55	18.5%
	Slightly less	18	12.2%	20	6.7%
	No change	78	53.1%	206	69.1%
	Slightly more	14	9.5%	14	4.7%
	Much more	9	6.1%	3	1.0%

RESULTS

This section presents the main results with their interpretations and is divided into two subsections according to the analysis used in the research (descriptive analysis, regression analysis).

Descriptive Analysis

As mentioned above, a total of 445 respondents participated in this research in the Slovak Republic, of which 147 were males and 298 were females (33% males and 67% females). Regarding the profile of respondents, females predominated over males. In terms of age variable, the sample was well equilibrated. Despite the benefits of online surveys, its limitations need to be considered. In this context, young people are much more online and the chance of being reached by a survey is higher. Also, females are more willing to participate in online research. There are also doubts about the capture of alcohol consumption in socially excluded groups (homeless people). These aspects have been addressed and explained in other studies focusing on online surveys of alcohol consumption across the population (19, 20). In this way, the value of the knowledge provided in the presented research is preserved.

The counts of responses are shown in **Tables 1**–**3**. The first glance at the tables indicated that females' drinking was more stable than males' drinking. Thus, in the case of females, the answer "no change" was selected much more often than in the case of males.

Table 1 shows the answers to the first question: Did you drink alcohol less or more often in the past month?

Based on the results in **Table 1**, it can be noted that 56.7% of females and 40.8% of males declared that their frequency of drinking did not change. "Much less" drinking was found in 23.1% of males and 18.8% of females, and "slightly less" in 11.6% of males and 10.7% of females. On the other hand, "slightly more" drinking was reported by 17% of males and 11.4% of females. The option "much more" was chosen by 7.5% of males and 2.3% of females. These results revealed that about half of the respondents did not change their drinking frequency during the first wave of the pandemic. Gender differences indicated that females were more stable than males in their drinking patterns. The changed alcohol consumption among the respondents was reflected in a decrease more than in an increase, for both males and females.

Table 2 shows the distribution of answers on the second question: Did the amount of alcohol you usually drink on each drinking occasion change in the past month?

As **Table 2** shows, in the second analyzed question, it was again possible to observe a relatively large difference between males and females. The answer "no change" was chosen by 68.8% of females and 50.3% of males. The answer "much less" was identified in 19.7% of males and 13.8% of females. The option "slightly less" was chosen by 12.2% of males and 8.7% of females. The "slightly more" option was chosen by 13.6% of males and 7.4% of females and the "much more" option was chosen by 4.1% of males and only 1.3% of females. Based on these results, it could be stated that the amount of alcohol consumed during the early COVID-19 pandemic did not change clearly in half of the respondents. Thus, the onset of the pandemic did not affect alcohol doses in these cases. The observed change was characterized by a lower amount of alcohol rather than a higher one. Again, females were more stable in their drinking patterns and less prone to higher alcohol consumption.

The answers to the third question "Did the frequency of drinking occasions where you drank a high amount of alcohol (i.e., 6 or more drinks) change in the past month" are shown in **Table 3**.

Table 3 presents the results of a descriptive analysis of the collected answers to the last question, which concerns in particular excessive drinking. Gender differences in behavior were also evident in this analyzed case. "No change" in excessive alcohol drinking during the lockdown due to COVID-19 was found in 53.1% of males and 69.1% of females. The option "much

less" was selected by 19% of males and 18.5% of females. "Slightly less" excessive drinking was reported by 12.2% of males and 6.7% of females. In the case of increased excessive alcohol consumption during the lockdown, the following results can be identified, 9.5% of males declared "slightly more" frequency of drinking occasions where they drank a high amount of alcohol and the option "much more" was found in 6.1% of male respondents. Females reported "slightly more" frequency of drinking occasions where they drank a high amount of alcohol in 4.7% of the analyzed cases and the option "much more" in 1% of these cases. In general, the results of excessive drinking revealed similar findings as in the previous cases. Thus, the change in excessive drinking during the early COVID-19 pandemic was not identified in more than half of the research sample. Less excessive drinking prevailed over more excessive drinking, while males appeared to be a vulnerable group in terms of changed risk behavior and excessive drinking.

Regression Analysis

The values of the coefficients of the binary logistic regression model for excessive drinking are presented in **Table 4**. The suitability of the model as a whole was verified by the Hosmer-Lemeshow test, with a *p*-value of 0.787 (Chi-square = 4.722, with 8 degrees of freedom), thus it could be assumed that the binary logistic regression model was correctly estimated. All possible explanatory variables were first considered, but only gender, age, smoking and changes in smoking behavior proved to be statistically significant variables in terms of an increase in excessive drinking. Thus, the final model in this study included explanatory variables such as gender, age, smoking and changes in smoking behavior:

- *Gender*–a binary categorical variable with a range of values: 0–female, 1–male.
- *Smoking*–a binary categorical variable with a range of values: 0–non-smoker, 1–smoker.
- *Changes in smoking behavior*–a categorical variable obtained as an answer to the question: Did you smoke less or more often in the past month? Permissible values were: 0–no change, 1–less smoking, 2–more smoking.
- *Age*–an interval variable with a range of values: ≤23, 24–27, 28–35, 36–45, 46+. The age variable was binned into intervals so that the individual age groups were equally numerous. Age was divided into quintiles to capture trends within given age groups of respondents, not just to obtain overall measure that would be captured if age was treated as a continuous variable.

The reference categories for given variables were set as follows:

- *Gender*–"female" gender was set as a reference category because descriptive analysis indicated that males were more prone to increased alcohol consumption.
- *Smoking*–"non-smoker" was set as a reference category because there was a presumption of a possible interdependence between alcohol and tobacco use.
- *Changes in smoking behavior*–"no change" was set as a reference category because the intention was to observe the possible interrelation between changes in smoking and changes in drinking.
- *Age*–"age interval 46+" was set as a reference category due to the assumption that the lockdown negatively affected rather young people than middle-aged people and older people in terms of excessive drinking.

The interpretation of the obtained regression coefficients is as follows. An increase in excessive drinking during the lockdown was more common among males than among females. Males were 2.15 times more likely to increase their excessive drinking than females [95% Confidence Interval (CI): 0.97–4.78]. With a focus on smoking, smokers were 3.36 times more prone to increase excessive drinking during the lockdown than non-smokers (95% CI: 1.49–7.57). In terms of changes in smoking behavior, the contrast value was "no change." Respondents who reported that they smoked more during the lockdown compared to the usual situation were 3.40 times more likely to increase excessive drinking than smokers whose smoking doses remained unchanged (95% CI: 1.07–10.84). It turns out that people have tendencies to use tobacco and alcohol interdependently, as compared to people who do not smoke. Moreover, an increase in smoking and an increase in excessive alcohol consumption seemed to be interconnected. On the other hand, less smoking was not significant. Focusing on age, where 46+ was a contrast value, the findings were as follows. Respondents aged < 23 years had 5.25 times higher chance of increased excessive drinking during the lockdown than respondents aged 46 years and more (95% CI: 1.10–25.06). The results for the age ranges 24–27 and 36–45 years were not statistically significant. Respondents aged 28–35 years were generally 5.76 times more likely to increase their excessive alcohol drinking during the lockdown than respondents aged 46 years and more (95% CI: 1.14–29.37).

TABLE 4 | Logistic regression analysis of the odds of an increased frequency of excessive drinking amongst respondents.

		95% Wald confidence interval for odds ratio		
	Odds ratio	**Lower**	**Upper**	***p*-value**
Gender				
Males	2.15	0.97	4.78	0.061
Smoking				
Smokers	3.36	1.49	7.57	0.003
Change in smoking behavior				
Change in smoking (less)	1.84	0.44	7.73	0.404
Change in smoking (more)	3.40	1.07	10.84	0.038
Age				
Age ≤ 23	5.25	1.10	25.06	0.038
Age 24–27	1.50	0.25	8.98	0.660
Age 28–35	5.76	1.14	29.37	0.040
Age 36–45	3.50	0.60	20.52	0.170

p-value was based on the Wald test. Reference categories: Gender (females); Smoking (non-smokers); Change in smoking behavior (no change). Age (46+).

DISCUSSION

The COVID-19 pandemic caused problems in many dimensions of countrie's lives (21). In the health dimension, the serious problems that existed before COVID-19 have not disappeared, but on the contrary, the pandemic exacerbated these problems in many cases. During the pandemic, not only reducing the incidence of COVID-19 (22) but also reducing alcohol consumption remains a public health priority (23).

Changes in Alcohol Consumption

In this study, most females did not report a change in alcohol consumption in terms of their answers to alcohol-related questions. In the individual analyzed cases, 56.7 to 69% of females reported unchanged drinking, while males, who did not change their drinking, ranged from 40.8 to 53.1%. Thus, males tended to change alcohol use more than females. In general, alcohol consumption in Slovaks did not change in about half of the respondents, which is in line with the previous European studies (6). In a comparison with European team of researchers, their results also showed that alcohol consumption did not change in about half of the respondents from European countries (6). With a focus on changed drinking in this study, it can be concluded that the change was reflected in a decrease in alcohol consumption more than in an increase, for both males and females. This is consistent with the findings revealed in the European study by Manthey et al. (6) and it can be concluded that the Slovak respondents reported similar rates as the European population included in the international research effort. The findings are in line with the assumption that lower levels of alcohol consumption can be expected at the beginning of the pandemic due to reduced alcohol availability (3). This can also be explained by the fact that during the COVID-19 lockdown, the availability of alcohol was lower in terms of closed bars, pubs, cafes, clubs and restaurants, and people could consume alcohol bought in the store only at home (24, 25). The change in off-premises alcohol consumption may not have been substantial in the short term, as could also be seen in an Australian study conducted by Vandenberg et al. (26).

A closer look at the results shows that 34.7% of males and 29.5% of females reported less frequent drinking during the COVID-19 pandemic. On the other hand, 24.5% of males and 13.7% of females reported more frequent drinking. Regarding the amount of alcohol used on drinking occasions, 32.2% of males and 22.4% of females reported lower amounts during the COVID-19 pandemic, while 17.8% of males and 8.6% of females reported higher amounts. Finally, the drinking occasions where the respondents drank a high amount of alcohol, declaring excessive alcohol drinking, were less frequent in 31.2% of males and 25.2% of females during the COVID-19 pandemic. This type of drinking occasions was more frequent in 15.6% of males and 5.7% of females. The results of this study can be compared with many others revealed in different countries. A very similar gender comparison was provided by a study from the UK (27) and it can be concluded that Slovak respondents reported more positive results than UK respondents, especially females. It is also possible to focus on other countries and their outcomes during the COVID-19 pandemic. Chodkiewicz et al. (28) found that more than 30% of respondents from their Polish survey changed their drinking as a result of the COVID-19 pandemic. According to the results, 16% of respondents drank less and 14% drank more. Similar results were revealed by Sidor and Rzymski (29). In France, 24.4% of alcohol drinkers reported a decrease in their alcohol consumption since the lockdown and 10.7% reported an increase (30). In Norway, 29.9% of respondents reported they drank less, whereas 13.3% reported they drank more (31). Thus, the tendency of changes in drinking was similar for respondents from the Slovak Republic as for respondents from other countries, where a decrease in alcohol consumption prevailed compared to an increase. Interestingly, in Germany, 34.7% of respondents reported that they drank more alcohol during the lockdown, 19.4% drank less alcohol, 37.7% reported no changes in their drinking patterns, and 8.2% did not drink alcohol (32). In this way, Slovak respondents reported more positive rates. These facts demonstrate the diversity of alcohol-related behavior across populations, and the determinants of change in alcohol consumption should be examined.

Determinants of Increased Excessive Drinking

Among other factors, it can be concluded that factors such as male gender, being smoker, more smoking and young age can be associated with an increase in excessive alcohol consumption on drinking occasions during the COVID-19 pandemic. Similar findings were revealed in other studies (1, 33–36).

The comorbidity of alcohol and tobacco consumption seems to be very important finding in terms of addressing substance use behavior. This indicates a comorbidity between various unhealthy behaviors, specifically smoking and drinking. In this context, it is possible to agree with the findings of Reynolds et al. (37), who revealed that increases in alcohol consumption were associated with increases in tobacco use during the COVID-19 lockdown. Similar findings were revealed by Zadarko-Domaradzka et al. (38), who focused on young adults in the Carpathian Euroregion. This finding can be explained by the fact that one type of risk behavior may encourage individuals to engage in other risk behaviors. Accordingly, the association between risk alcohol consumption and the use of other addictive substances was also confirmed in other studies (39–41).

This study also contributes to the knowledge that young age is considered a determinant of increased alcohol consumption, as confirmed by Vanderbruggen et al. (36), Calina et al. (1) and Gonçalves et al. (33). Also, Jacob et al. (35) emphasized that a higher proportion of respondents with increased alcohol consumption was more pronounced among young adults aged 18–34 years. Similar results can be found in other studies (42). For instance, the study of Ahmed et al. (43) revealed that young adults aged 21–40 years were more vulnerable in terms of their mental health conditions and alcohol consumption during the COVID-19 pandemic. The explanation can be found in social, enhancement and coping motives, which are strong at a young age (44, 45). In this context, alcohol expectancies can play an important role in this fact, and it is also true that expectancies

linearly decrease with increasing age (46). This encourages the implementation of campaigns to inform the population about the potential long-term effects of increased alcohol and tobacco consumption (47).

From a gender point of view, other studies have also shown that males are prone to change in drinking, while they tended to drink more than females (33, 34, 42, 43). These findings reflect the well-known fact that males are more vulnerable to drinking than females (12, 48, 49). Males are characterized by less healthy lifestyles, less social and normative barriers, and they also perceive alcohol-related problems differently than females; therefore, fewer protective factors can be expected for males (48, 50). This can also be seen in the light that, although females generally consume less alcohol than males, it is females who suffer a much higher risk of alcohol-related health damage and present a more vulnerable profile with less willingness to undergo treatment (49, 51). On the other hand, male vulnerability was not confirmed in a study conducted by Garnett et al. (52).

Implications for Public Policies

It is important to realize that alcohol is already a long-term problem in society, which represents a burden from a health, economic and social point of view (53–55), while the COVID-19 pandemic is another serious threatening factor (1, 56–58). In the Slovak Republic, addiction and alcohol abuse were ubiquitous diseases even before the pandemic, but it is the pandemic that can make them worse. For this reason, Slovak experts in the field of addictology can be expected to face major challenges even after the pandemic. All these facts underline the need to monitor changes in drinking among populations during and after the COVID-19 pandemic (59, 60).

The findings of this study should be considered when developing prevention programs aimed to reduce risky drinking in the Slovak Republic, where these programs are lacking. This study is an important appeal for policy-makers and decision-makers to make greater efforts to improve the situation, to pay increased attention to this problem, to remove barriers and to create adequate conditions. Monitoring alcohol consumption across the Slovak population is essential, but it is also very important to put effective measures into practice and compare the results. Alcohol-related problems should be integrated into general health policies, strategies and interventions. It is public health policies that have the potential to influence alcohol consumption in the population (3, 61). Based on the presented results, it is recommended that Slovak decision-makers and policy-makers develop alcohol use prevention policies for younger individuals, males and smokers. Regarding the identified reduction in alcohol consumption during the COVID-19 lockdown in Slovaks, there are opportunities to encourage people to continue this trend, as well as to motivate individuals with plans to quit drinking and reduce their alcohol consumption. The implementation of public measures and interventions to stop drinking forever without being exposed to stigma seems to be an effective step (62, 63). Campaigns and programs aimed at reducing alcohol consumption, eliminating misinformation and health education are even more justified in the case of vulnerable populations. Slovak public policies and services should consider a response to impending problems and harmful drinking not only during the COVID-19 pandemic, but also in the post-pandemic period. Improving health literacy across the Slovak population can help to achieve positive outcomes in the field of health and addictology (64, 65), and there are other effective measures (66).

Strengths, Limitations and Future Directions

The strengths of the study lie in its importance and value for the country, where this social problem has long been overlooked and unresolved, resulting in inadequate services and interventions to help addicts. This study contributes with important findings on the change in alcohol consumption and determinants against the background of excessive drinking during the COVID-19 lockdown in the Slovak Republic. The presented results offer a closer look at the situation in the Slovak Republic and contribute to comprehensive international knowledge. The findings of this study encourage the implementation of effective and evidence-based strategies, which are more than necessary in this country. A valuable platform of results revealed by the presented research can help this effort regardless of the pandemic period. The pandemic multiplies the power of research findings and requires that all tools and information be used to successfully address this sensitive and very often stigmatized social problem.

This research did not avoid the limitations to which the partially unbalanced nature of the research sample could be included. Thus, there was a higher proportion of females and younger respondents. However, this deficiency should not be considered as undermining the value of knowledge in the Slovak Republic. Another possible limitation is the fact that the study included a smaller research sample that was investigated only in one country.

By respecting these limitations, future research should include a larger sample and more countries should be involved in the research. Also, future research ambitions should be focused on examining the individual characteristics linked to changes in unhealthy behavior on a larger scale. Accordingly, other patterns of unhealthy behavior (tobacco use, illegal drug use, excessive use of sedatives, non-substance use) and other individual factors (having children, living situation, type of employment, work status, marital status, education level, mental health) should be taken into account and covered in future research. Personal perceptions of health, self-care and self-monitoring could offer a more detailed look at changes in population behavior during the COVID-19 pandemic. Last but not least, future research should focus on investigating the problem after the COVID-19 pandemic, with an emphasis on established interventions and measures.

CONCLUSIONS

The COVID-19 pandemic disrupted people's lives in many dimensions, which could translate into changes in unhealthy

behavior, including alcohol consumption. For public health professionals and leaders, it is important to know the current situation and the main determinants of excessive alcohol drinking. This was provided for Slovak professionals and leaders in the presented study with the ambition of further investigation.

The aim of this study was to examine changes in alcohol consumption and to identify determinants against the background of excessive drinking during the COVID-19 lockdown in the Slovak Republic. Descriptive analysis and binary logistic regression were used to meet the main aim. The main findings showed that the frequency of excessive drinking did not change in about half of respondents. With a focus on changed excessive drinking, it was possible to conclude that the change was reflected in a decrease more than in an increase, both among males and females. Amongst Slovak respondents, an increase in excessive drinking was more common among males, younger people, smokers, and smokers who increased smoking during the lockdown. In fact, the individual characteristics linked to alcohol consumption need to be constantly examined, not only in the short term but also in the long term, as the consequences of the pandemic can last for a long time. The authors appeal to alcohol prevention with a closer focus on young adults, males and current smokers, as they seem to be most at risk from problematic alcohol consumption.

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 guidelines of the Declaration of Helsinki. The survey was completely anonymous and personal data were protected in accordance with the European Union Regulation 2016/679 of the European Parliament and Council, which facilitates ethical assessment. The research was approved by the Ethics Committee of the Clinical Trials Services, USP TECHNICOM, Technical University of Košice, Slovakia (Ref. 02/04/2020 IG Bioinformatics). Informed consent was obtained from all subjects involved in the research.

AUTHOR CONTRIBUTIONS

BG: conceptualization, investigation, resources, writing—original draft preparation, writing—review and editing, supervision, project administration, and funding acquisition. SK: conceptualization, investigation, writing—original draft preparation, writing—review and editing, supervision, project administration, and funding acquisition. VI: conceptualization, investigation, resources, writing—original draft preparation, writing—review and editing, visualization, and supervision. MK: conceptualization, methodology, software, validation, formal analysis, investigation, writing—original draft preparation, and writing—review and editing. All authors contributed to manuscript revision, read, 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.2021.791077/full#supplementary-material

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Public Confidence in COVID-19 Prevention and Response in Bangladesh

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Community confidence in institutional approaches to emergency management directs how they cooperate and comply with public policy responses. In the context of emerging COVID-19 pandemic risk management, this study aims to assess public confidence in the Government of Bangladesh (GoB) and private sector entities for the activities undertaken during preparedness, prevention, and response phases. A survey was conducted with 307 respondents who willingly took part in the study. Cronbach's alpha was calculated to assess the internal reliability and the Mann-Whitney U test was conducted to estimate the mean score difference between the observations. A confirmatory factor analysis (CFA) was applied in the study. The findings suggest that the participants were highly positive about the GoB efforts to organize and provide PPE for doctors in time as a safeguard against COVID-19 and coordination and informed decision making in relation to facing COVID-19. Overall, the participants showed a lower-level confidence in the preparedness and response measures taken by authorities in Bangladesh. The results explored how the GoB failed to reach the public satisfaction level regarding provision of food and financial support to low income and middle income people. A lack of collaboration and coordination among different inter-GoB and private sectors makes mitigation and recovery process difficult. This research provides a set of policy recommendations for future public health emergency management based on the participants' concerns and suggestions, and a review of consequences of policy responses in the early stage.

Keywords: COVID-19, confidence, preparedness, response, risk management, Bangladesh

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INTRODUCTION

The very first confirmed case of COVID-19 was registered in Bangladesh on March 8, 2020. According to the Government of Bangladesh (GoB), as of 23rd May 2021, the number of confirmed infected cases and reported deaths in Bangladesh are 789,080 and 12,356, respectively (1). In response to the COVID-19 pandemic, the GoB has undertaken some non-medical and medical policy interventions such as ensuring limited gatherings for praying at mosques, social isolation, self-isolation, social distancing, quarantine, the opportunity to work from home, lockdown, travel restrictions, closure of non-essential services, flight restrictions, continuous disinfection, and

sterilization initiatives. The GoB announced a nationwide holiday for 10 days from March 26, 2020 to April 4, 2020 which is recognized as "lockdown." People were asked to avoid social gatherings and travel and to maintain good hygiene. The government of Bangladesh (GoB) deployed the army to ensure social distancing at that time. Based on the situation, the lockdown was prolonged up to May 30, 2020. The GoB has taken two different types of lockdown, namely partial and full lockdown. During the time of full lockdown, people were prohibited from going outside, except for emergency medical reasons. During partial lockdown, people were allowed to do their daily necessary activities and work duties while maintaining social distancing. Although several strategies and policies have been undertaken and implemented throughout Bangladesh with the aim of averting the negative effects of COVID-19, there exists a concern about the effectiveness of these measures. Several factors are responsible for this ineffectiveness such as late incorrect decision making, lack of knowledge about virus dissemination, lack of timely decisions and implementation, fake news and misinformation, and lack of resources (2, 3). Due to the lack of coordination and cooperation among various government institutions, non-government organizations, and the community, the GoB was unable to succeed completely in implementing lockdown for fighting against the pandemic (4).

It is difficult to prepare strategically or respond promptly when combating emerging or existing challenges when limited resources are available (4, 5). Public and private health services were completely inexperienced at the onset of the COVID-19 outbreak in Bangladesh. At that time, the country lacks substantial sectoral medical policy, strategy, resources, and regulatory frameworks which are essential to fight against the COVID-19 pandemic (2). Thermal scanners were installed in three international airports, namely Hazrat Shahjalal International Airport, Dhaka; Osmani International Airport, Sylhet; and in Shah Amanat International Airport, Chittagong, to measure the body temperature of a significant number of inbound passengers using infrared technology. Due to an inadequate number of testing kits, it was impossible to conduct a rapid test identifying an accurate number of confirmed COVID-19 cases. Healthcare staff and other frontline workers including the police, the army, and cleaners have not been supplied with adequate personal projecting equipment (PPE) to protect themselves from coronavirus infections (6). The country has only 5.3 doctors for every 10,000 residents, 0.3 nurses for every 1,000 people, 0.87 hospital beds for every 1,000 people, and 1.1 ventilators for every 100,000 population showing the fragility of the medical sector to the emerging threat of COVID-19 (7).

In this vulnerable situation, public engagement in prevention initiatives relies heavily on faith and confidence in the healthcare system. Trust is measured based on prior familiarity with the healthcare system. Confidence and belief in the health sector leads people to support and comply with public health programs (8). An individual's relationship with healthcare services relies strongly on faith (9). High level of awareness and knowledge are correlated with more favorable attitudes toward COVID-19 prevention activities (10–12). Bangladeshi people are highly superstitious and engulfed with false ideas about the virus spread and diagnostic procedures. It is time that the authorities start awareness campaigns to foster public confidence and ensure public participation and compliance with medical and non-medical policy measures (13). To being this campaign, the authority must know the existing confidence level of the people of Bangladesh in the GoB and private sectors for preparing for and responding to COVID-19. Limited research was conducted to assess the residents' confidence in preparedness and response measures undertaken by the GoB and private sectors at the early stage of the COVID-19 pandemic in Bangladesh. Thus, this study aims to examine Bangladeshi residents' confidence in preparedness and response measures undertaken by the GoB and private sectors between January and May 2020.

METHODS AND APPROACHES

Study Area and Data Collection Procedure

Bangladesh is a South Asian country inhabited by **166,423,708** people. The country has an area of 148,560 km^2 positioned at 20° 30′ to 26° 45′ N latitude and 88° 0′ to 92° 45′ E longitude. Data was collected through questionnaires in electronic format dated between 12 April and 11 June 2020. A questionnaire based on structured questions was constructed and posted in the online Google Docs platform that was disseminated to the participants via e-mail and social media. Thus, a convenience sampling was applied to collect data from potential participants aged above 18. A total of 307 respondents participated in this study where significant respondents were from Dhaka and Chattogram. Participants were made aware of the purpose and context of this survey so that informed consent was confirmed. Anonymity of the respondents is ensured in this research. The questions used a 5-point Likert scale, ranging from 1 to 5 (strongly disagree, disagree, neutral, agree, and strongly agree).

Questionnaire and Internal Reliability

A structured questionnaire was prepared to collect data on preparedness and response measures taken by the GoB and private sectors. The questionnaire consists of three major sections. The first section includes participant's socio demographic characteristics including age, gender, marital status, area of residence, sectors of work, income, and education levels. The second section containing 23 items focusing on participants' trust in preparedness and response measures taken by the GoB. The last part covers 5 items related to the preparedness, response and business continuity initiatives adopted by authorities of the private sector in Bangladesh between January and May 2020. An open-ended section was available in both section 2 and 3 for the participants to indicate whether they were unsatisfied with or mistrusted the activities of GoB and private sectors.

Internal reliability is a widely used metric that examines whether different items on the same test produce similar result based on correlations between them (14). Cronbach's alpha measure to test internal reliability has been utilized in this study. The Cronbach's alpha (∞) ranges between 0 and 1. This tool has been used by several researchers to identify inconsequential items in a questionnaire survey e.g., Emerson (15), Liu (16), Muhaimin

TABLE 1 | Items in each factor and their internal reliability.

Variable	Items in each factors	Cronbach's alpha
	Factor 1: Government preparedness	
GP1	The government of Bangladesh held the information about the immigrants and database of the immigrants and organized quarantine arrangements for the foreign visitors in time as a safeguard against COVID-19.	0.789
GP2	The government of Bangladesh organized home quarantine/separate arrangements/isolation for repatriates Bangladeshi in time as a safeguard against COVID-19.	0.779
GP3	The government of Bangladesh organizes sterilization of non-passenger's goods/product/items that arrived from overseas in time as a safeguard against COVID-19.	0.787
GP4	The government of Bangladesh organized countrywide sterilization and disinfection activities in time as a safeguard against COVID-19.	0.779
GP5	The government of Bangladesh organizes testing support for the suspects of COVID-19 infected patient in time as a safeguard against COVID-19.	0.771
GP6	The government of Bangladesh organized and prepared hospitals for affected people in time as a safeguard against COVID-19.	0.775
GP7	The government of Bangladesh organized and provided PPE for doctors in time as a safeguard against COVID-19.	0.798
GP8	The government of Bangladesh organized food and support for the low-income people in time.	0.798
GP9	The government of Bangladesh organized food and support for the middle-income people and other people who become jobless during COVID-19 pandemic.	0.858
GP10	There are lacking in coordination and decision making exists in relation to facing COVID-19?	0.792
GP11	The government entities in Bangladesh have organized basic health services, food management and education facilities (through distance/online learning) to deal with the consequences of the epidemic diseases such as COVID-19 pandemic.	0.786
	Factor 2: Response effort	
RE1	All the agencies within the government of Bangladesh have prepared response and business continuity plans to deal with the consequences of epidemic diseases such as COVID-19 pandemic in time.	0.625
RE2	All the preventive, responsive, and business continuity plans prepared by the different agencies within the government of Bangladesh will be able to deal with the consequences of epidemic diseases such as COVID-19 pandemic in time.	0.591
RE3	All the government agencies within the government of Bangladesh have the required capabilities to deal with the consequences of COVID-19 pandemic and ensure the business continuity through providing services by implementing the business continuity plans.	0.621
RE4	The agencies within the government of Bangladesh are successful in implementing the media response plans for risk communication providing accurate and timely information about COVID-19.	0.613
RE5	A sample was taken from the community to develop the response and business continuity plans in the various government sectors to insure the suitability of these plans during epidemic diseases such as COVID-19 pandemic.	0.623
RE6	The government entities in Bangladesh have the flexibility to deal with the consequences of the epidemic diseases such as COVID-19 pandemic.	*0.644*
RE7	The Government of Bangladesh is one of the model countries in dealing with COVID-19 pandemic and business continuity?	0.660
RE8	Do you think that some of the procedures and services (i.e., work from home, online meeting, tele-prescription, online services provision etc.) provided by the government entities in Bangladesh to cope with COVID-19 pandemic will be continuing in the future and change government service delivery mechanism?	0.677

(Continued)

TABLE 1 | Continued

Variable	Items in each factors	Cronbach's alpha
	Factor 3: Private sector's preparedness	
PP1	All the private organizations in Bangladesh have prepared response and business continuity plans to deal with the consequences of epidemic diseases such as COVID-19 pandemic in time.	0.601
PP2	All the preventive, responsive, and business continuity plans prepared by the different private organizations in Bangladesh will be able to deal with the consequences of epidemic diseases such as COVID-19 pandemic.	0.682
PP3	A sample was taken from the community to develop the response and business continuity plans in the private organizations from various sectors to insure the suitability of these plans during epidemic diseases such as COVID-19 pandemic.	0.652
PP4	The private entities within Bangladesh have the flexibility to deal with the consequences of the epidemic diseases such as COVID-19 pandemic.	0.663
PP5	Do you think that some of the procedures and services (i.e., work from home, online meeting, tele-prescription, and online services provision etc.) provided by the private entities in Bangladesh to cope with COVID-19 pandemic will be continuing in the future and change private sector service delivery mechanism?	0.627

et al. (17). However, the alpha score higher than 0.7 is desirable and an alpha score higher than 0.55 is acceptable (18).

Table 1 shows good values of Cronbach's alpha in government preparedness, and acceptable values for response effort and private sector's preparedness. In summary, the internal consistency of the data is satisfactory.

Statistical Analysis

Likert data was compared using Mann–Whitney-U test for two groups: (i) Male and female and (ii) Government and Private sectors to compare if the response variable deviates between these two groups (19–21). Further, factor analysis determines the underlying factors or latent variables among the questionnaire items or observed variables. Factor analysis can be two types: exploratory factor analysis (EFA) and confirmatory factor analysis (CFA). For this study, EFA was eliminated as it is more data-driven regarding hypothesized measurement model explicitly to be examined (22, 23). Moreover, this method also has been used to perceive the people's perception in different aspect during COVID-19 situation (24, 25). Particular variables relate to factors; thus, CFA is employed in this study (26). However, an ideal standardized factor loading should be higher than 0.5, and ideally 0.7 or higher. Therefore, a revised CFA model was derived by eliminating several variables with standardized factor loadings lower than 0.5.

$$Y = \wedge\xi + \epsilon \tag{1}$$

The observed parameters are Y, the unobserved latent constructs are ξ, the number of factor loadings is $\wedge$, and the probabilistic case is estimated by ϵ iteratively lessening the fit function (27).

The sample size needed for CFA should be at least 200–300 participants (28). The CFA was performed on the three factors: government preparedness and response effort, and private sector preparedness. The CFA is utilized to test the fit between the measurement model and actual data. Here, the measurement model was assessed by the following Tucker-Lewis's index (TLI), Comparative Fit Index (CFI), and root-mean-square error of approximation (RMSEA) to fit the conventional cutoff principles (29–31). TLI, CFI, and RMSEA are defined based on the fit function. The statistical equations for the above three tools are as follows, following (32):

$$TLI = 1 - \frac{\frac{F_H}{df_H}}{\frac{F_B}{df_B}} \tag{2}$$

$$CFI = 1 - \frac{F_H}{F_B} \tag{3}$$

$$RMSEA = \sqrt{\frac{F_H}{df_H}} \tag{4}$$

The significance level ($p =< 0.001$) is considered for factor loadings. Where, base model and hypothesized model are, respectively, indicated by H and B. Both $F_H$and F_B are the minimized fit function of the respective models. Model degrees of freedom denoted by df_H and df_B.

RESULTS

Socio-Demographic Characteristics of the Participants

The socio-demographic characteristics of the participants have been shown in **Table 2**. Out of 307 participants, 236 were male and 71 were female. There exists age variation among the

TABLE 2 | Socio-demographic characteristics of the participants.

Items/Characteristics of the participants	Frequency (%)
Gender	
Male	236 (76.9)
Female	71 (23.1)
Marital status	
Single	174 (56.7)
Married	130 (42.3)
Preferred not to tell	3 (1)
Age group	
18–30	199 (64.8)
31–50	102 (33.2)
51–65	6 (2)
Place of living	
Dhaka	148 (48.2)
Chattogram	118 (38.4)
Khulna	14 (4.6)
Rajshahi	11 (3.6)
Mymensnigh	9 (2.9)
Barishal	4 (1.3)
Sylhet	3 (1.0)
Education level	
SSC	1 (0.3)
HSC	18 (5.9)
Diploma	3 (1.0)
Bachelor degree	126 (41)
Master degree	140 (45.6)
Doctor of Philosophy (PhD)	19 (6.2)
Sector of work	
Public	112 (36.5)
Private	195 (63.5)

TABLE 3 | Descriptive statistics of the variables.

Variables	Mean	Std. Dev	Variance	Skewness	Kurtosis
GP1	2.93	1.18	1.4	0.107	−1.22
GP2	2.87	1.26	1.58	0.119	−1.28
GP3	3.18	1.08	1.18	−0.277	0.655
GP4	3.29	1.22	1.49	−0.324	−1.02
GP5	3	1.22	1.5	0.211	−1.2
GP6	3.07	1.22	1.49	−0.0176	−1.26
GP7	3.46	1.14	1.3	−0.261	−1.04
GP8	2.52	1.02	1.04	0.312	−0.92
GP9	3.41	1.1	1.2	−0.543	−0.558
GP10	1.92	1.01	1.03	1.38	1.7
GP11	3.07	1.12	1.26	0.17	−1.01
RE1	3.36	1.11	1.22	−0.221	−1.06
RE2	3.13	0.997	0.993	−0.2	−0.958
RE3	3.41	0.982	0.965	−0.501	−0.474
RE4	3.13	1.06	1.12	0.211	−1.23
RE5	3	1.01	1.03	0.106	−0.757
RE6	3.15	1.06	1.12	−0.0313	−0.962
RE7	3.74	1.16	1.35	−1.03	0.373
RE8	2.56	0.975	0.951	0.86	0.0483
PP1	3.3	1.1	1.2	−0.672	−0.521
PP2	3.14	1.07	1.15	−0.424	−0.734
PP3	3.13	0.96	0.921	−0.442	−0.576
PP4	3.08	1.07	1.14	0.0643	−1.06
PP5	2.45	0.837	0.7	1.25	1.65

participants. Three age groups are identified. In total, 64.8, 33.2, and 2% of participants are in the age groups of 18–30, 31–50, and 51–65 years, respectively. Most of the participants have completed a master's degree (45.6%), followed by a bachelor's degree (41%), doctor of philosophy (PhD) (6.2%), higher secondary school certificate (HSC) (5.9%), diploma (1%), and secondary school certificate (SSC) (0.3%). The percentage of participants working for public and private sectors were 63.5 and 36.5%, respectively (**Table 2**).

Descriptive Statistics of the Variables

Descriptive statistics of the variables including mean, standard deviation, variance, skewness, and kurtosis have been measured. A summary of the initiated variables is provided in **Table 3**. The highest mean, standard deviation, variance, skewness, and kurtosis values are 3.74 (RE7), 1.22 (GP5 and GP6), 1.58 (GP2), 1.38 (GP10), and 1.7 (GP10), respectively.

Confirmatory Factor Analyses Model

The initial CFA model of three factors (government preparedness, response effort, and private sector preparedness) is shown in **Table 4**. The factor loadings with its *p*-value for each item have been included in the **Table 4**. An ideal standardized factor loading should be higher than 0.5 and ideally 0.7 or higher (33).

Therefore, a revised CFA model was derived by eliminating several variables which had standardized factor loadings lower than 0.5. The eliminated variables are GP8, GP9, GP10, RE4, RE6, RE7, RE8, PP4, and PP5. The final CFA of public confidence on risk management toward government and private sectors is presented in **Table 5**. **Table 6** represents the parameter estimates and goodness of fit measures of the final model. It is apparent that CFI, TLI, and RMSEA values are 0.932, 0.920, and 0.070, respectively. It indicates the results found from the model CFA are acceptable.

Difference in Mean Items Scores Between Male and Female Groups

A Mann-Whitney U test has been performed to assess if the observation of any randomly drawn sample is larger than the other or the distributions are equal. A Mann-Whitney U test was conducted to measure the mean scores difference between the study variables of male and female groups and government and private sectors sample (**Tables 7**, **8**). The test results suggest that there are statistically significant differences in the mean scores of GP2 and GP3, GP4, GP5, GP6, GP8, GP11, and RE8 on male and

TABLE 4 | Initial factor loadings and *P*-value of the items.

Factors	Variable	*p*-value	Stand. estimate	Included/excluded
Government preparedness	GP1	< 0.001	0.6238	Included
	GP2	< 0.001	0.6392	Included
	GP3	< 0.001	0.6851	Included
	GP4	< 0.001	0.7548	Included
	GP5	< 0.001	0.6604	Included
	GP6	< 0.001	0.7343	Included
	GP7	< 0.001	0.6866	Included
	GP8	< 0.001	0.4171	Excluded
	GP9	< 0.001	0.4123	Excluded
	GP10	< 0.001	−0.2786	Excluded
	GP11	< 0.001	0.5635	Included
Response effort	RE1	< 0.001	0.5224	Included
	RE2	< 0.001	0.6212	Included
	RE3	< 0.001	0.5544	Included
	RE4	< 0.001	0.4921	Excluded
	RE5	< 0.001	0.5666	Included
	RE6	< 0.001	0.4585	Excluded
	RE7	< 0.001	0.4295	Excluded
	RE8	0.007	0.1703	Excluded
Private sector preparedness	PP1	< 0.001	0.7845	Included
	PP2	< 0.001	0.8276	Included
	PP3	< 0.001	0.5873	Included
	PP4	0.133	0.0951	Excluded
	PP5	0.093	0.1069	Excluded

TABLE 5 | Revised factor loading and *P*-value of each variable.

Factor	Variable	*p*-value	Stand. estimate
Government Preparedness	GP1	< 0.001	0.620
	GP2	< 0.001	0.650
	GP3	< 0.001	0.682
	GP4	< 0.001	0.770
	GP5	< 0.001	0.671
	GP6	< 0.001	0.736
	GP7	< 0.001	0.678
	GP11	< 0.001	0.539
Response Effort	RE1	<0.001	0.522
	RE2	< 0.001	0.715
	RE3	<0.001	0.554
	RE5	< 0.001	0.618
Private Sector Preparedness	PP1	< 0.001	0.789
	PP2	< 0.001	0.829
	PP3	< 0.001	0.586

TABLE 6 | Goodness of fit measures of CFA model.

Fit indices	Parameter estimates	
	Initial	Final
Comparative Fit Index (CFI)	0.685	0.932
Tucker Lewis Index (TLI)	0.651	0.920
Root Mean Square Error of approximation (RMSEA)	0.102	0.070

female groups, respectively. Equal observations are measured for the remaining variables (**Table 7**).

Difference in Mean Items Scores Between Government and Private Sector Groups

A Mann-Whitney U test has also been conducted for the observation of government and private sectors to explore the difference in the mean score between those two distributions. It is evident that there were statistically significant differences in the mean scores of GP1, GP8, and PP3 variables (**Table 8**). The rest of the observations follow the null hypothesis that there is equal probability of exceeding one random observation than the other.

DISCUSSION

The research was based on the perception of Bangladeshi citizens of risk management against COVID-19. The CFA result suggests that GP4 "The government of Bangladesh organized countrywide sterilization and disinfection activities in time as a safeguard against COVID-19" was the most significant variable for Governmental preparedness. For response effort RE2 "All the preventive, responsive, and business continuity plans prepared by the different agencies within the government of Bangladesh will be able to deal with the consequences of epidemic diseases such as COVID-19 pandemic in time." was found as the most significant variable for response effort. For private sector preparedness, "All the preventive, responsive, and business continuity plans prepared by the different private organizations in Bangladesh will be able to deal with the consequences of epidemic diseases such as COVID-19 pandemic" was determined as the most important variable.

From the Mann-Whitney U test, the findings suggest statistically significant variations in the mean scores of GP2, GP3, GP4, GP5, GP6, GP8, GP11, and RE8. Thus, there was a disparity between the perceptions of males and females. Moreover, there were significant variations in the mean score of the GP1, GP8, and PP3 metrics which indicate that there exists distinctive perception among participants working for the government and private sectors.

A high degree of public confidence in institutions and a low level of perceived danger is a favorable state in normal conditions. Public confidence established on the impression of integrity, caring and transparency of the government might cause citizens to overlook risks and therefore minimize their conviction in the need to undertake individual measures to manage risks (8). However, in the case of a pandemic like COVID-19, public enforcement is difficult. As part of the findings, the government of Bangladesh arranged sterilization of non-passenger goods/products/items that arrived from overseas, as well as food and support for low-income citizens as a precaution against COVID-19. This calls into question the risk research presumption that open communication, especially of complexities, enables the community to make critical choices (34).

TABLE 7 | Test results of Mann-Whitney U test on female and male groups.

Variables	Group	N	Mean	*p*-value
GP1	Female	71	2.97	0.089
	Male	236	3.24	
GP2	Female	71	2.62	0.018
	Male	236	3.03	
GP3	Female	71	3.04	0.039
	Male	236	3.35	
GP4	Female	71	2.99	0.014
	Male	236	3.41	
GP5	Female	71	2.80	0.004
	Male	236	3.29	
GP6	Female	71	2.87	0.008
	Male	236	3.31	
GP7	Female	71	3.24	0.060
	Male	236	3.55	
GP8	Female	71	2.46	0.010
	Male	236	2.81	
GP9	Female	71	3.39	0.759
	Male	236	3.47	
GP10	Female	71	2.00	0.337
	Male	236	1.93	
GP11	Female	71	2.86	0.011
	Male	236	3.24	
RE1	Female	71	3.25	0.348
	Male	236	3.39	
RE2	Female	71	3.20	0.521
	Male	236	3.14	
RE3	Female	71	3.38	0.772
	Male	236	3.41	
RE4	Female	71	2.92	0.120
	Male	236	3.13	
RE5	Female	71	2.89	0.538
	Male	236	2.96	
RE6	Female	71	3.38	0.128
	Male	236	3.17	
RE7	Female	71	3.66	0.228
	Male	236	3.79	
RE8	Female	71	2.49	0.047
	Male	236	2.74	
PP1	Female	71	3.15	0.713
	Male	236	3.21	
PP2	Female	71	3.07	0.919
	Male	236	3.05	
PP3	Female	71	3.06	0.371
	Male	236	2.94	
PP4	Female	71	3.01	0.619
	Male	236	3.09	
PP5	Female	71	2.52	0.929
	Male	236	2.49	

TABLE 8 | Test results of Mann-Whitney U test on government and private sector groups.

Variables	Group	*N*	Mean	*p*-value
GP1	Government Sector	112	2.93	0.006
	Private Sector	195	3.32	
GP2	Government Sector	112	2.87	0.493
	Private Sector	195	2.97	
GP3	Government Sector	112	3.18	0.299
	Private Sector	195	3.34	
GP4	Government Sector	112	3.29	0.806
	Private Sector	195	3.33	
GP5	Government Sector	112	3.00	0.057
	Private Sector	195	3.28	
GP6	Government Sector	112	3.07	0.127
	Private Sector	195	3.29	
GP7	Government Sector	112	3.46	0.709
	Private Sector	195	3.49	
GP8	Government Sector	112	2.52	0.015
	Private Sector	195	2.85	
GP9	Government Sector	112	3.41	0.481
	Private Sector	195	3.47	
GP10	Government Sector	112	1.92	0.494
	Private Sector	195	1.96	
GP11	Government Sector	112	3.07	0.373
	Private Sector	195	3.20	
RE1	Government Sector	112	3.36	0.903
	Private Sector	195	3.36	
RE2	Government Sector	112	3.13	0.777
	Private Sector	195	3.16	
RE3	Government Sector	112	3.41	0.795
	Private Sector	195	3.39	
RE4	Government Sector	112	3.13	0.646
	Private Sector	195	3.06	
RE5	Government Sector	112	3.00	0.516
	Private Sector	195	2.91	
RE6	Government Sector	112	3.15	0.468
	Private Sector	195	3.26	
RE7	Government Sector	112	3.74	0.583
	Private Sector	195	3.77	
RE8	Government Sector	112	2.56	0.097
	Private Sector	195	2.75	
PP1	Government Sector	112	3.30	0.100
	Private Sector	195	3.13	
PP2	Government Sector	112	3.14	0.148
	Private Sector	195	3.01	
PP3	Government Sector	112	3.13	0.010
	Private Sector	195	2.88	
PP4	Government Sector	112	3.08	0.888
	Private Sector	195	3.07	
PP5	Government Sector	112	2.45	0.780
	Private Sector	195	2.53	

An updated CFA model was estimated. Few variables such as GP8, GP9, GP10, RE4, RE6, RE7, RE8, PP4 and PP5 were eliminated because their uniform factor loadings were < 0.5. It is also noted that the GoB had coordinated national sterilization and disinfection activities as a precaution against COVID-19, which was important in the risk management of COVID-19. However, in terms of the organization of essential health services, food management, and education facilities (via distance/online learning), Bangladeshi government institutions could deal with the implications of the COVID-19 pandemic. The population was pessimistic that Bangladesh had the flexibility to cope with the effects of infectious diseases. Good governance can only be accomplished by an intelligent early warning system, accurate review of the situation, understanding, exchange, and use of functional expertise and intelligence (35). However, the most striking aspect was the lack of coordination and decision-making for the government's COVID-19 situation. It was an unexpected situation for Bangladesh, like many other nations. The government was not ready enough to deal with a crisis that it never experienced in the past. The findings are consistent with those of (36–38).

It has been noted that, instead of monitoring the rumors and misinformation, propaganda, and hate speech, the GoB cracks down on those who condemn its treatment of the ongoing social media crisis. It has had a detrimental effect on public trust (39). There was a positive alliance of confidence that prevention, sensitivity, and business continuity strategies planned by the various private organizations in Bangladesh could cope with the effects of infectious diseases such as COVID-19. The GoB claimed that private organizations played an important role in the distribution of preventive messages during COVID-19 and collaborated closely with local authorities and government officials in the planning/management of quarantine/isolation centers. However, the findings of this research are in contrast with the government's argument. The outcome has shown that private companies within Bangladesh do not have the flexibility to cope with the effects of infectious diseases such as COVID-19.

CONCLUSIONS

The findings suggest that the initiatives taken for COVID-19 by governmental and private entities were not sufficient. The GoB has adopted several major practices to combat this crisis. In comparison, the private sectors do not have such flexibility or capacity to combat with the current pandemic situation. The GoB should either facilitate the operations of private sectors and NGOs, or consider the lack of complete flexibility of non-governmental sectors and act accordingly. Nevertheless, private sectors should step forward with their highest capacity and fight the pandemic situation along with the mainstream governmental initiatives. A monitoring body for activities in the private sector might be beneficial for enhancing the public trust in the private sector. Policy makers should specially consider these phenomena, regarding the functional, capacitive, and operational difference between the public and private sectors while making the policy. Pandemic influenza risk management policy should not be constant since the situation is fluctuating frequently. Policies and initiatives should be adopted with recent studies and data. The only way to establish a strong public trust is to develop an effective and coordinative system between the public and private sectors in terms of healthcare, consistent social distancing policy implementation with sustained livelihood options for those in need, and other emergency service provisions for all.

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 in the article/supplementary material. The data presented in the study are deposited at: https://docs.google.com/spreadsheets/d/1odIZzwyTGgSj3kpPZ-YpoXCSiPV8KXjQgEVnL4Uqw1w/edit?fbclid=IwAR1mXpJkDH2SPBJarFU4s6yXKtq6DbB5C8EpOORUdGb-p8fB79uhznMgv_0#gid=0.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Institutional Review Board, University of Chittagong. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

EA, KR, and A-EH: conceptualization, validation, investigation, writing—original draft preparation, and writing—review and editing. EA and A-EH: formal analysis, methodology, data curation, and visualization. EA and KR: supervision and resources. All authors contributed to the article and approved the submitted version.

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Impact of Safety Nets on Household Coping Mechanisms for COVID-19 Pandemic in Malawi

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Background: Covid-19 pandemic induced various shocks to households in Malawi, many of which were failing to cope. Household coping mechanisms to shocks have an implication on household poverty status and that of a nation as a whole. In order to assist households to respond to the pandemic-induced shocks positively, the government of Malawi, with support from non-governmental organizations introduced Covid-19 Urban Cash Intervention (CUCI) and other safety nets to complement the existing social protection programs in cushioning the impact of the shocks during the pandemic. With these programmes in place, there is a need for evidence regarding how the safety nets are affecting coping. Therefore, this paper investigated the impact that safety nets during Covid-19 pandemic had on the following household coping mechanisms: engaging in additional income-generating activities, receiving assistance from friends and family; reducing food consumption; relying on savings; and failure to cope.

Methods: The study used a nationally representative panel data from the Malawi High Frequency Phone Survey on Covid-19 (HFPS Covid-19) and complemented it with the fifth Integrated Household Panel Survey (IHPS), also known as living standards measurement survey. Five Random Effects Probit Models were estimated, one for each coping mechanism.

Results: Findings from this study indicated that beneficiaries of safety net programs were more likely to rely on remittances from friends and family than the people who had no safety nets. Furthermore, the safety net recipients were less likely to reduce food consumption or rely on savings than the non-recipients. Despite the interesting findings, we also noticed that safety nets had no significant impact on household engagement in other income-generating activities in response to shocks.

Conclusion: The results imply that safety nets in Malawi during the Covid-19 pandemic had a positive impact on consumption and prevented the dissolving of savings. Therefore, these programs have to be scaled up, and the volumes be revised upwards.

Keywords: health economics, COVID-19 Malawi, health policy Malawi, public policy Malawi, safety nets, COVID-19 Africa, social protection programs Malawi, COVID-19 urban cash intervention Malawi

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INTRODUCTION

Countries, including Malawi, responded in various ways to the novel Covid-19 pandemic that disrupted many economies around the world. Malawi introduced various containment measures to reduce the spread of the virus. These measures, included compulsory screening of all travelers coming into the country at the port of entry, a ban on all travelers from highly affected countries, restrictions on public gatherings to a maximum of 100 people and closure of all schools (1). These measures, coupled with people's fears of the novel virus, partly contributed to the disruptions in the supply chains of various goods and services in the country (1). Business operations were also affected as opening hours were restricted.

As a result, Covid-19 Pandemic induced other shocks to households, communities and nations apart from being a health shock in itself (2–4). According to the National Statistical Office (NSO) of Malawi, the uppermost shocks that the households reported to have experienced from mid-March to July 2020 as a result of Covid-19 pandemic included a fall in the price of farming/business output reported by 66% of the interviewed households. An increase in price of farming/business inputs and disruption of farming, livestock, and/or fishing activities were experienced by 30 and 29% of the households, respectively (5). Whereas, from August 2020 to January 2021, the statistics show that 59% of the interviewed households were affected by an increase in price of major food items consumed, 36% by an increase in price of farming/business inputs and 20% by non-farm business closure (6). This shows that most of the Covid-19 induced household shocks were not idiosyncratic in nature as they likely affected a large proportion of individuals within the sample and beyond.

As such, the affected households no longer turned to each other for assistance or for credit and most of them were finding it hard to cope with the shocks that they faced. For instance, 78% of the households who were hit by one or more shocks from March to July 2020 did nothing in response to these shocks (5). This has negative implications since such households were likely to move into poverty if shocks persisted or they would not be able to move out of it if they were already poor. On top of that, 20 and 31% relied on savings from March to July 2020 and August 2020 to January 2021, respectively (5, 6). Channeling savings into household consumption has long term negative implications on household investment and, therefore that of the nation.

On top of that, reliance on savings is not sustainable, and there was a high probability that such households would move into poverty and fail to cope if shocks persisted. In turn, all these pose a challenge toward eradicating poverty as highlighted in the development agendas such as Sustainable Development Goals (SDGS), Malawi Vision 2063, Pan African Vision 2063, and the Malawi Growth and Development Strategy (7–10). Therefore, it is important to understand how households had been responding to these shocks given that coping responses have an implication on the households' socio-economic well-being and that of a nation as a whole.

Literature shows that health shocks trigger borrowing or assistance from friends and family rather than the use of any other strategy as these shocks are idiosyncratic (11–14). However, evidence of a reduction in these informal-risk sharing coping mechanisms during Covid-19 pandemic has also been reported elsewhere (15). Additionally, others (16) also found evidence that there was less reliance on savings during a lockdown as a result of Covid-19 pandemic. However, these studies did not consider the economic interventions that had been put in place given their recency and the role they played in assisting households cope positively with various shocks.

In order to assist households to respond to the economic crisis due to pandemic positively, the government of Malawi, with support from Non-Governmental Organizations introduced Covid-19 Urban Cash Intervention (CUCI) to complement the existing social protection programs. Safety nets play a big role in replacing lost incomes for households affected by various economic shocks and those facing credit constraints to avoid the use of negative coping mechanisms and improve their consumption and increase their asset holdings (17–20). In this regard, this study was implemented to investigate the impact that safety nets during Covid-19 pandemic had on household coping mechanisms for the pandemic in Malawi.

The study matters and it is of significance to undertake in Malawi at this point and offers lessons beyond Malawi. Firstly, it feeds into the development agenda for Malawi as it potentially shows the aspects that may help put the country on track with the agenda. The Malawi development agenda is guided by the United Nations Sustainable Development Goals (SDGs), whose goal number 1 is to "end poverty in all its forms everywhere." Under this goal, target 3 stresses the "implementation of nationally appropriate social protection systems and measures for all, including floors, and by 2030 achieve substantial coverage of the poor and the vulnerable." Target 5 states, "by 2030, build the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate related extreme events and other economic, social and environmental shocks and disasters" (7). Therefore, this study established the role of safety nets during Covid-19 pandemic in reducing household vulnerability to shocks and building their resilience to future shocks for the realization of these targets in Malawi. Hence, the study speaks directly to SDGs 1 and 5.

Furthermore, Goal number 2 under the SDGs is to "end hunger, achieve food security and improve nutrition and promote sustainable agriculture." Target number 1 under this goal states: "by 2030, end hunger and ensure access by all people, in particular, the poor and the people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round." Target 2 states: "by 2030, end all forms of malnutrition, including achieving, by 2025, the internationally agreed targets on stunting and wasting in children under 5 years of age, and address the nutritional needs of adolescent girls, pregnant and lactating women, and older persons" (7). Guided by this, the goal on the key priority area of Health and Population Management of the Malawi Growth and Development Strategy (MGDS III), is to "Improve health and quality of the population for sustainable socio-economic development" and one of the outcomes is "reduced morbidity and mortality due to malnutrition" through "promoting dietary diversity and consumption of high nutrient

value by addressing the production and marketing bottlenecks particularly of fruits" (9). Therefore, this study established the role of safety nets in offsetting household reduction in food consumption as a response to a shock, since this mechanism has a negative implication on household nutrition status. This also impacts the nutrition status for school-going children, which eventually impacts their learning outcomes and, hence, the potential for a vicious circle of ex-ante child poverty.

All in all, the study contributes to the existing literature on the importance of safety nets during a crisis in achieving the goal of poverty eradication in the medium term through building household resilience to shocks. It also assessed the role of safety nets in enabling household investments to achieve the long-term goal of transforming the Malawi nation into an upper middle-income nation by 2063 as per the aspiration of Malawi vision 2063. This was achieved through an empirical assessment of the impact that safety nets have on the following household coping mechanisms in response to a shock during the pandemic: engaging in additional income-generating activities, receiving assistance from friends and family; reducing food consumption; relying on savings; and failure to cope. In addition, it is the first study within the region and Malawi in particular, which assess the coping aspect in the times of COVID-19.

METHODS

Data

The paper used survey data of Malawi High Frequency Phone Survey on Covid-19 (HFPS-Covid-19) that was conducted by NSO with support from the World Bank. The survey aimed to monitor the socio-economic impacts of Covid-19 pandemic on households in Malawi. This paper used the second and the third waves of the survey. The study also drew some variables from the fifth Integrated Household Panel Survey. The data is readily available for public use and free to download from the World Bank website. https://microdata.worldbank.org/index.php/catalog/3766.

Variables

In the second and third waves, the households were asked if they experienced any shock(s) due to Covid-19. Each household would list the shock(s) and one coping mechanism they used in response to each. The study mainly focused on five coping mechanisms that were mostly reported by the households. Therefore, the dependent variables were these coping mechanisms: engaging in additional income generating activities, receiving assistance from friends and family, reducing food consumption, relying on savings, as well as doing nothing. These variables took a value of 1 if the household adopted that particular mechanism and a 0 otherwise.

As explanatory variables, the models included the variable on whether the household was a beneficiary of any social safety net program. The variable was binary, bearing the value of 1 for a beneficiary and a 0 for a non-beneficiary. The models also included variables on household demographic characteristics of; size, number of dependents, and number of household members above 18 years old. Also included were household head characteristics of: age, sex (which took the value of 0 if the household head was male and the value of 1 if the head was female), their education level, their sector of employment (which took the value of 0 if the household head was employed in a non-agricultural sector and 1 if they were employed in the agricultural sector), and marital status (which took the value of 1 for married household heads and 0 for unmarried household heads). Other household characteristics in the model included the wealth category of the household, its place of residence (which took the value of 0 for households in the rural area and 1 for those in the urban area), as well, as region. On top of that, the shock variables categorized into economic shocks, health shocks and socio-political shocks were also included. Also considered in the study as one of the explanatory variables was the scope of the shocks, i.e., whether the shock was an idiosyncratic or covariate. This variable took the value of 1 if the shock was idiosyncratic and 0 otherwise.

TABLE 1 | Descriptive statistics.

Variable	Obs.	Mean	Std. Dev.	Min	Max.
Safety nets beneficiary	3,140	5%	0.213	0	1
Age of head	3,140	42	14.225	16	98
Female head	3,140	21%	0.405	0	1
Household size	3,140	5	2.274	1	19
Number of dependents	3,140	2	1.532	0	12
People Above 18 years old	3,140	2	1.164	1	9
Head has no education	3,140	3%	0.169	0	1
Head has primary education	3,140	51%	0.5	0	1
Head has secondary education	3,140	37%	0.484	0	1
Head has tertiary education	3,140	9%	0.287	0	1
Head in married	3,140	77%	0.423	0	1
Agricultural sector	3,140	25%	0.432	0	1
Wealth quintile 1	3,140	32%	0.467	0	1
Wealth quintile 2	3,140	26%	0.44	0	1
Wealth quintile 3	3,140	20%	0.398	0	1
Wealth quintile 4	3,140	13%	0.337	0	1
Wealth quintile 5	3,140	9%	0.285	0	1
Urban	3,140	37%	0.482	0	1
Northern region	3,140	15%	0.356	0	1
Central region	3,140	42%	0.494	0	1
Southern region	3,140	43%	0.495	0	1
Idiosyncratic shock	3,140	51%	0.5	0	1
Economic shock	3,140	72%	0.448	0	1
Health shock	3,140	9%	0.289	0	1
Socio political shock	3,140	17%	0.378	0	1
Engaging in other activities	3,140	2%	0.135	0	1
Receiving assistance from friends and family	3,140	2%	0.126	0	1
Reducing food consumption	3,140	3%	0.156	0	1
Relying on savings	3,140	9%	0.284	0	1
Doing nothing	3,140	39%	0.487	0	1

Data Analysis

Firstly, descriptive statistics and cross-tabulations were computed to understand the characteristics of the sample for this study. These are presented in **Tables 1–3**. Then after the

TABLE 2 | Distribution of coping mechanisms.

	Engaging in other activities		Receiving assistance		Reducing consumption		Relying on savings		Doing nothing	
	No.	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
Sex of head										
Male	47	81	27	53	63	81	229	83	937	77
Female	11	19	24	47	15	19	48	17	272	23
Total	58	100	51	100	78	100	277	100	1,209	100
Education										
No education	0	0	1	2	3	4	4	1	49	4
Primary	37	64	27	53	33	42	124	45	673	56
Secondary	16	28	22	43	35	45	111	40	414	34
Tertiary	5	8	1	2	7	9	38	14	73	6
Total	58	100	51	100	78	100	277	100	1,209	100
Marital status										
Unmarried	11	19	23	45	14	18	57	21	291	24
Married	47	81	28	55	64	82	220	79	918	76
Total	58	100	51	100	78	100	277	100	1,209	100
Employment sector										
Non-agriculture	43	74	43	84	69	89	240	87	815	67
Agriculture	15	26	8	16	9	11	37	13	394	33
Total	58	100	51	100	78	100	277	100	1,209	100
Region										
North	20	35	18	35	12	15	25	9	149	12
Central	20	35	16	32	9	12	129	47	519	43
Southern	18	30	17	33	57	73	123	44	541	45
Total	58	100	51	100	78	100	277	100	1,209	100
Residence										
Rural	35	60	27	53	46	59	157	57	814	67
Urban	23	40	24	47	32	41	120	43	395	33
Total	58	100	51	100	78	100	277	100	1,209	100
Wealth										
Wealth quintile 1	10	17	13	26	38	49	105	38	334	28
Wealth quintile 2	18	31	15	29	17	22	79	29	302	25
Wealth quintile 3	15	26	10	20	5	6	47	17	266	22
Wealth quintile 4	11	19	10	20	8	10	27	9	180	15
Wealth quintile 5	4	7	3	5	10	13	19	7	127	10
Total	58	100	51	100	78	100	277	100	1,209	100

descriptive analysis, the econometric analysis was done. Five Random Effects Probit Models were run, because of the binary nature of the outcome variables, one for each coping mechanism. On top of these, gender and regional Random Effects Models were also run to establish if there are heterogeneities in terms of gender and region. Results for the various econometric analysis done, are shown in **Tables 4**–**8**.

RESULTS

Descriptive Statistics

As shown in **Table 1**, about 5% of the households in the sample benefited from at least one of the social protection programs. These included free food, Social Cash Transfers (SCTs), CUCI, other cash transfers, as well as other in-kind transfers (excluding food). The table also indicates that the average age of heads of the households that were included in the sample was 42, with the youngest head being 16 and the oldest being 98 years old.

On top of that, the sample largely comprised male headed households, with about 21% of the households being headed by a female. The table also shows that 77% of the household heads in this sample were married while the rest were unmarried. The unmarried category included those who had never been married, those who divorced/separated, and those who were widowed. In terms of household size, the average number of members per household in this sample was five. The smallest household had one member, and the largest had 19 household members.

On top of that, the average number of dependents per household, as well as adults above 18 years old, was two. In addition, about half of the households were headed by a member

with primary education (51%), almost 37% had secondary education, whereas 9 and 3% of household heads had tertiary and no education, respectively. The sample also comprised households whose majority were employed in a non-agricultural sector, with about 25% being employed in the agricultural sector. In terms of wealth categories, a large proportion of the households in the sample (32%) were in the lowest quintile, whereas the top quintile consisted of about 9% of the households in the sample.

Regarding location, the majority of the households in this sample lived in the rural areas, with about 37% living in the urban areas. Furthermore, 15% of the households was in the Northern region, 42% was in the central region and 43% was from the southern region. This means the study was dealing with households mainly from the central and southern regions.

In terms of shock distribution, 72% of shocks experienced by the households were economic related shocks which included: job loss, non-farm business closure, increase in price of farming/business inputs, fall in the price of farming/business output, as well increase in the price of major food items consumed. Almost 9% of the household shocks were health shocks which included illness, injury, or death of income-earning member of the household. At the same time, 17% were socio-political shocks which were disruption of farming, livestock and fishing activities as well as theft/looting of cash and other property. On top of that, 51% of all these shocks were idiosyncratic in nature as they only affected one household at a particular time.

Out of the households that experienced at least a shock in this sample, about 39% failed to cope with the shocks, 9% relied on their savings, 3% reduced their food consumption, whereas

TABLE 3 | Distribution of shocks.

	Economic shocks		Health shocks		Socio-political shocks	
	No.	**%**	**No.**	**%**	**No.**	**%**
Region						
North	300	13	54	19	94	17
Central	958	42	141	49	255	47
Southern	1,008	45	94	32	194	36
Total	2,266	100	289	100	543	100
Place of residence						
Rural	1,475	65	195	67	402	74
Urban	791	35	94	33	141	26
Total	2,266	100	289	100	543	100

TABLE 4 | Marginal effects-overall probit models.

	Engaging in additional income generating activities	Receiving assistance from friends and family	Reducing food consumption	Relying on savings	Doing nothing
Safety nets beneficiary (0/1)	0.00625 (0.013)	0.0486** (0.019)	−0.0284** (0.014)	−0.0517*** (0.016)	−0.0123 (0.037)
Age of head (log)	0.00704 (0.009)	0.00715 (0.008)	−0.0186 (0.019)	−0.00527 (0.018)	0.0399 (0.031)
Female (0/1)	−0.00560 (0.006)	0.0192** (0.009)	−0.00750 (0.016)	−0.00842 (0.017)	0.0159 (0.029)
Household size (log)	0.0264** (0.011)	−0.0180* (0.011)	0.0864*** (0.026)	−0.000519 (0.026)	−0.0501 (0.043)
Dependents	−0.00390 (0.003)	0.00147 (0.003)	−0.0257*** (0.007)	0.000885 (0.006)	0.0119 (0.011)
Adults above 18 years (log)	−0.0232*** (0.009)	0.00442 (0.009)	−0.0603*** (0.021)	0.0117 (0.021)	0.0422 (0.036)
No education		−0.00312 (0.015)	0.0274 (0.025)	−0.0485 (0.037)	0.0945* (0.049)
Secondary education	−0.00766 (0.006)	0.00240 (0.005)	0.00652 (0.012)	0.00113 (0.012)	−0.0350* (0.020)
Tertiary education	0.00941 (0.010)	−0.0208 (0.013)	0.00103 (0.021)	0.0273 (0.019)	−0.0922*** (0.035)
Married (0/1)	0.00489 (0.006)	−0.000611 (0.006)	0.0101 (0.016)	0.00214 (0.017)	−0.0156 (0.028)
Agricultural sector (0/1)	−0.00101 (0.005)	−0.00680 (0.005)	−0.0262** (0.010)	−0.0563*** (0.011)	0.0828*** (0.021)
Wealth quintile 2	0.0152** (0.006)	−0.00114 (0.006)	−0.0229 (0.015)	0.00312 (0.015)	−0.0159 (0.024)
Wealth quintile 3	0.0178** (0.007)	0.000517 (0.007)	−0.0490*** (0.014)	−0.0158 (0.016)	0.0137 (0.028)
Wealth quintile 4	0.0251** (0.011)	0.00806 (0.009)	−0.0336* (0.017)	−0.0175 (0.019)	0.0147 (0.033)
Wealth quintile 5	0.0117 (0.012)	−0.00164 (0.009)	0.00161 (0.027)	−0.0235 (0.021)	0.0161 (0.035)
Urban (0/1)	0.00901 (0.007)	0.00361 (0.005)	0.00287 (0.012)	−0.00648 (0.012)	−0.00139 (0.021)
Central region	−0.0417*** (0.012)	−0.0158* (0.008)	−0.0588*** (0.019)	0.0474*** (0.014)	0.0495* (0.027)
Southern region	−0.0430*** (0.012)	−0.0174** (0.008)	0.00352 (0.021)	0.0372*** (0.013)	0.0367 (0.027)
Idiosyncratic shock (0/1)	−0.00618 (0.006)	0.00969 (0.006)	−0.0340*** (0.012)	0.0343*** (0.012)	0.0517** (0.021)
Economic shock (0/1)	0.0269*** (0.004)	0.00313 (0.006)		0.0920*** (0.010)	0.363*** (0.019)
Health shock (0/1)	−0.00854 (0.006)	0.0128 (0.008)		−0.0600*** (0.012)	−0.0645** (0.030)
Socio-political shock (0/1)	−0.0147*** (0.004)	−0.0126*** (0.004)		−0.0589*** (0.010)	0.0611*** (0.023)
N	3,048	3,140	1,638	3,140	3,140

Standard errors in parentheses.
$^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

TABLE 5 | Northern region regression results on safety nets.

	Engaging in additional income generating activities	Receiving assistance from friends and family	Reducing food consumption	Relying on savings	Doing nothing
Safety nets beneficiary	0.00598 (0.013)	0.0482** (0.019)	−0.0253 (0.016)	−0.0521*** (0.016)	−0.0134 (0.036)
Controls	Yes	Yes	Yes	Yes	Yes
N	3,048	3,140	1,638	3,140	3,140

Standard errors in parentheses.
**p < 0.1, **p < 0.05, ***p < 0.01.*
*Full table is in **Appendix**.*

TABLE 6 | Central region regression results on safety nets.

	Engaging in additional income generating activities	Receiving assistance from friends and family	Reducing food consumption	Relying on savings	Doing nothing
Safety nets beneficiary	0.00412 (0.012)	0.0489** (0.019)	−0.0284** (0.014)	−0.0515*** (0.016)	−0.0119 (0.037)
Controls	Yes	Yes	Yes	Yes	Yes
N	3,048	3,140	1,638	3,140	3,140

Standard errors in parentheses.
**p < 0.1, **p < 0.05, ***p < 0.01.*
*Full table is in **Appendix**.*

TABLE 7 | Southern region regression results on safety nets.

	Engaging in additional income generating activities	Receiving assistance from friends and family	Reducing food consumption	Relying on savings	Doing nothing
Safety nets beneficiary	0.00745 (0.013)	0.0508** (0.020)	−0.0255 (0.016)	−0.0524*** (0.016)	−0.0139 (0.036)
Controls	Yes	Yes	Yes	Yes	Yes
N	3,048	3,140	1,638	3,140	3,140

Standard errors in parentheses.
**p < 0.1, **p < 0.05, ***p < 0.01.*
*Full table is in **Appendix**.*

TABLE 8 | Male head regression results on safety nets.

	Engaging in additional income generating activities	Receiving assistance from friends and family	Reducing food consumption	Relying on savings	Doing nothing
Safety nets beneficiary	0.00625 (0.013)	0.0486** (0.019)	−0.0284** (0.014)	−0.0517*** (0.016)	−0.0123 (0.037)
Controls	Yes	Yes	Yes	Yes	Yes
N	3,048	3,140	1,638	3,140	3,140

Standard errors in parentheses.
**p < 0.1, **p < 0.05, ***p < 0.01.*
*Full table is in **Appendix**.*

2% engaged themselves in other income generating activities, and another 2% received assistance from friends and family. This means the rest used other mechanisms not included in this analysis. This implies that a good number of households were indeed failing to cope with various shocks during this Covid-19 pandemic either because of the magnitude of the shocks or they did not have the capacity to respond to the shocks using any other mechanism.

TABLE 9 | Female head regression results on safety nets.

	Engaging in additional income generating activities	Receiving assistance from friends and family	Reducing food consumption	Relying on savings	Doing nothing
Safety nets beneficiary	0.00625 (0.013)	0.0486** (0.019)	−0.0284** (0.014)	−0.0517*** (0.016)	−0.0123 (0.037)
Controls	Yes	Yes	Yes	Yes	Yes
N	3,048	3,140	1,638	3,140	3,140

Standard errors in parentheses.
$^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.
*Full table is in **Appendix**.*

Distribution of Coping Mechanisms

Table 2 indicates that the majority of households who indicated to have been engaged in other income generating activities, received assistance from friends and family, reduced food consumption, relied on savings or failed to cope after experiencing a shock were headed by a male member.

The majority of households headed by someone with primary education were using all the mechanisms except reducing food consumption in response to a shock. On top of that, the majority of those relying on savings were employed in the non-agricultural sector.

In terms of location, those who relied on savings and those who failed to cope with the shocks were mainly from the central and southern region. In contrast, most of those who engaged in additional income-generating activities and those who received assistance were from the northern region. On top of that, more than half of those who reduced their food consumption were from the country's southern region. In addition to that, all the five mechanisms used in the analysis were mainly used by households that lived in the rural areas.

Those who reduced food consumption relied on savings, and failed to cope in response to a shock were mainly the poorest (lowest quintile). At the same time, the majority of those who engaged in other income generating activities and those who received assistance from friends and family were in the second lowest quintile of wealth.

Distribution of Shocks

In terms of distribution of the three types of shocks, households in the central, southern, and rural areas had been hard hit compared to those in the north and in the urban areas. This is shown in **Table 3**.

Econometric Results

Moving away from the descriptive analysis, we present the regression results in the following sections. The results are presented as marginal effects and shown in **Table 4**. It had been established through this analysis that being a beneficiary of any safety net program had a significant impact on the following coping mechanisms to shocks during Covid-19 pandemic; receiving assistance from friends and family, reducing food consumption and relying on savings. The first and final columns of the table indicate no significant impact of safety nets programs on household engagement in additional income generating activities as a coping mechanism and on failure to cope after experiencing a shock during the pandemic.

As compared to a non-beneficiary household, a beneficiary household of any social safety net program was 5% more likely to rely on assistance from friends and family, 3% less likely to reduce food consumption, and 5% less likely to rely on savings in response to a shock.

Other factors that affected the household probability of adopting a specific coping mechanism included; sex of household head, household size, number of dependents in a household, number of household members above 18 years old, education of household head, sector of employment, and region. In addition to these variables, the scope as well as the type of shock experienced by a household also had an impact on the adoption of a specific coping mechanism. When hit by a shock, a female-headed household was about 2% more likely to receive assistance from friends and family as compared to a male-headed household, all things being the same.

As the household size increased, the household was more likely to engage in additional income-generating activities, less likely to receive assistance from friends and family, and more likely to reduce food consumption in response to a shock. On top of that, a unit increase in the number of dependents in a household was associated with less likelihood of reducing food consumption as a coping mechanism to shocks, all things being equal. On top of that, an increase in household members above 18 years was associated with less likelihood of engaging in additional income generating activities, and less likelihood of reducing food consumption in response to a shock. In addition, households for non-educated heads were more likely to fail to cope with any shock during the pandemic than those with primary education. Whereas, household heads with secondary and tertiary education were less likely to fail to cope with the shocks than those with primary education, all things being the same.

Compared to those employed in the non-agricultural sector, those in the agriculture sector were less likely to reduce food consumption or rely on savings. On the other hand, these households were more likely to fail to cope, unlike those in the non-agricultural sector. Compared to those in the lowest quintile of wealth (the poorest); the affluent households were more likely to engage in other income generating activities in response to a

shock. The latter were also less likely to reduce food consumption as a coping mechanism.

In terms of regions, households in the central region were more likely to respond to a shock by relying on savings and more likely to fail to cope than those in the northern region. Households in the southern region were also more likely to rely on savings when a shock hits as compared to those in the northern region, all things being the same. On the other hand, those in the central and southern regions were less likely to engage in additional income generating activities and receive assistance from friends and family as compared to those in the northern region. In addition, those in the central region were also less likely to reduce food consumption in response to a shock unlike those in the northern region.

Idiosyncratic shocks were more likely to trigger reliance on savings and less likely to reduce food consumption as coping responses to shocks compared with covariate shocks. On top of that, if hit by an idiosyncratic shock during the pandemic, a household was more likely to fail to cope as compared to being hit by a covariate shock. In terms of shock types, economic shocks were more likely to trigger engagement in additional income generating activities as a coping response, whereas socio-political shocks were less likely to trigger this coping mechanism. On top of that, economic shocks were more likely to trigger reliance on savings and a high likelihood of failure to cope. On the other hand, when faced with a health shock, a household was less likely to rely on savings or fail to cope. Besides, households that faced a socio-political shock were more likely to fail to cope with the shock but less likely to receive assistance from friends and family or rely on savings.

To assess heterogeneity in the results across regions, regional regressions were run and the results are as presented in **Tables 5**–**7**.

We found safety nets to be associated with a high likelihood of receiving assistance from friends and family as a household coping mechanism to shocks across all three regions. However, the results showed a significantly larger difference in the likelihood of seeking assistance between beneficiaries of social protection programs and non-beneficiaries in the southern region than the differences that existed in the other regions. There was also a significantly larger impact in the southern region. The beneficiary's likelihood of relying on savings was much lower than that of the non-beneficiary compared to the other regions.

A significantly large difference in the likelihood of reducing food consumption as a shock response also existed in the central region, unlike the other regions. In the area, any social protection program beneficiary was about 3% less likely to reduce food consumption in response to a shock than a non-beneficiary. Whereas, in the other regions, the probabilities' differences were not statistically significant. Full regional regression tables are in the **Appendix**.

Heterogeneity across genders was also assessed, and the results are as presented in **Tables 8**, **9**

Gender regressions showed safety nets having a significant impact on receiving assistance from friends and family, reducing food consumption, and relying on savings for both households headed by males and females. The results showed no differences across the genders. Full gender regression tables are also in the **Appendix**.

DISCUSSION

Interesting results emanate from the study. Firstly, we established that households that benefited from various safety nets programs during the pandemic were less likely to reduce food consumption and rely on savings. Thus, the findings support what was also established in Ethiopia and other African countries (21). This may suggest a positive development, given that by affecting households in that way, it may help them accumulate some wealth, thereby reducing some perpetual poverty. Even though such a positive development was observed, the safety net recipients were also more likely to rely on remittances from friends and family. The results appear to be contrary to what we may expect in normalcy. Furthermore, the result is in contrast to what was established in other studies where it has been shown that the safety nets are associated with reduced dependence on partners and relatives compared to not having the safety nets (22).

Based on the above, we may speculate that this was such a case since most of the times, the households that are included in these programs hardly make enough incomes from which they can save (23, 24). When hit by any shock, such households rely more on assistance, whether formal safety net programs or informal remittances from friends and family. A finding that supports what was established in the context of other shocks in the Philippines and other developing countries, where these coping acted as insurance (25). Furthermore, the results also imply that the assistance being received was mainly being channeled into household consumption and not necessarily into household investment since we did not find evidence that the beneficiaries were more likely to engage in additional income generating activities than non-beneficiaries. This finding, therefore, is in line with the literature that established the cushioning effect of these safety nets (26–28). This may be because most of the targeted beneficiaries were urban poor, who were probably living hand to mouth situation, and that Covid-19 exacerbated the situation.

Apart from the result narrated, education also played an important role. We noted that households headed by an uneducated member were more likely to fail to cope with the shocks during the pandemic. Most of the time, they hardly have reliable incomes or connections to enable them to use other coping mechanisms. On the other hand, those with secondary and tertiary education had enough financial as well as human capital that enabled them to cope with the shocks in one way or the other. These findings were contrary to those by (29) who found that household head's education was not significantly related to any specific shock response behavior.

In this study, those in the third and fourth quintiles of wealth (the rich) were less likely to reduce food consumption in response to a shock than those in the lowest quintile (the poor). This supports the findings by (13) and can be explained by the fact that the former make enough incomes from other income generating activities enabling them to cover for their food consumption needs during a shock unlike the poor. This was also evidenced

from the results that those in the second to the upper quintiles were more likely to engage in additional income generating activities in response to shocks as compared to the poorest since they have enabling financial and other resources.

The impact of household demographic characteristics implies that a household would reduce its food consumption in response to a shock if its size increased unless the additional member was a dependent. This is plausible as dependents have a lot of nutritional requirements, unlike others. And also, the household was likely to engage in additional income-generating activities if the additional member was below the age of 18. This is so since such members require a lot of support from the elder members, thereby forcing them to look for other activities where they can generate income from.

The finding that idiosyncratic shocks were more likely to trigger failure to cope was in contrast with a risk-sharing theory which stipulates that households have a wide range of coping mechanisms during an idiosyncratic shock unlike a covariate shock (30). On the other hand, this was plausible during this pandemic since many households had been affected by at least one shock, which made it hard for households to use other mechanisms of borrowing or seeking assistance from friends and family, rather they relied more on their own savings. This means that each household was in this pandemic and facing its impacts alone.

The paper has also established that there are regional differences in terms of coping mechanisms adopted by households during the pandemic. Unlike in other regions, there is a significant impact of safety nets on reduction of food consumption as a coping mechanism to shocks by households in the central region. Beneficiaries in this region are less likely to reduce food consumption as a shock response than non-beneficiaries. This may be explained by the fact that the highest proportion (55.8%) of people in the central region are poor unlike the other regions (31). Malawi Poverty Estimates 2020 by the NSO also established that the central region has the highest ultra-poverty rate (25.4%) and poverty is also deeper in this region at 20.1% as compared to other regions. Therefore, any levels of remittances in this region may likely have a significant impact on household food consumption unlike in other regions. We recognize the limitations of the study. First, the study is based on recall data, and hence bias may be an issue. Secondly, the methodology used does not address endogeneity and should be interpreted in the current methodology (32–34). Given our results, these results have some implications for research. Firstly, future studies should try to use other quasi-experimental methods such as an instrumental variable approach to see if the findings remain robust to the method of estimation. In our case, the lack of a proper instrument in the data made this a problem for us. Despite these limitations, the study has important implications for policy. The government of Malawi should increase the level and size of the transfers being used as they benefit the recipients, but they are not adequate to enable them to invest.

CONCLUSION

We have established through this study a significant impact of safety nets on the increasing probability of household reliance on remittances from friends and family and decreasing the probability of food reduction and reliance on savings as coping mechanisms to shocks. The safety nets programs during Covid-19 pandemic likely improved the beneficiaries' nutrition status. However, these programs had no significant impact on household engagement in other income generating activities, as well as households' failure to cope. This implies they had no impact on household investment. Therefore, these safety net programs during the pandemic have to be scaled up. The amount of funds has to be revised upwards to enable households to have enough incomes to cover both consumption and investment needs. This will in turn, make vulnerable households self-reliant and reduce their dependency on remittances from friends and family during a crisis as this mechanism also has a negative impact on the incomes of the households rendering this assistance, especially during this pandemic as almost every household had been affected in one way or the other.

In addition to that, upon investing, vulnerable households may be able to accumulate enough asset holdings and build resilience to future shocks. They may eventually graduate from these social protection programs, and new vulnerable households will be able to be recruited and assisted likewise. In turn, the goal of poverty eradication will be achieved in Malawi.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/**Supplementary Materials**. The data is available for free download at https://microdata.worldbank.org/index.php/catalog/3766.

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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Assessing the Spatiotemporal Spread Pattern of the COVID-19 Pandemic in Malaysia

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Introduction: The unprecedented COVID-19 pandemic has greatly affected human health and socioeconomic backgrounds. This study examined the spatiotemporal spread pattern of the COVID-19 pandemic in Malaysia from the index case to 291,774 cases in 13 months, emphasizing on the spatial autocorrelation of the high-risk cluster events and the spatial scan clustering pattern of transmission.

Methodology: We obtained the confirmed cases and deaths of COVID-19 in Malaysia from the official GitHub repository of Malaysia's Ministry of Health from January 25, 2020 to February 24, 2021, 1 day before the national vaccination program was initiated. All analyses were based on the daily cumulated cases, which are derived from the sum of retrospective 7 days and the current day for smoothing purposes. We examined the daily global, local spatial autocorrelation and scan statistics of COVID-19 cases at district level using Moran's I and SaTScan™.

Results: At the initial stage of the outbreak, Moran's I index > 0.5 ($p < 0.05$) was observed. Local Moran's I depicted the high-high cluster risk expanded from west to east of Malaysia. The cases surged exponentially after September 2020, with the high-high cluster in Sabah, from Kinabatangan on September 1 (cumulative cases = 9,354; Moran's I = 0.34; $p < 0.05$), to 11 districts on October 19 (cumulative cases = 21,363, Moran's $I = 0.52$, $p < 0.05$). The most likely cluster identified from space-time scanning was centered in Jasin, Melaka (RR = 11.93; $p < 0.001$) which encompassed 36 districts with a radius of 178.8 km, from November 24, 2020 to February 24, 2021, followed by the Sabah cluster.

Discussion and Conclusion: Both analyses complemented each other in depicting underlying spatiotemporal clustering risk, giving detailed space-time spread information at district level. This daily analysis could be valuable insight into real-time reporting of transmission intensity, and alert for the public to avoid visiting the high-risk areas during the pandemic. The spatiotemporal transmission risk pattern could be used to monitor the spread of the pandemic.

Keywords: spatial autocorrelation, SaTScan, Moran's I, COVID-19, LISA, space-time scan

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INTRODUCTION

Coronavirus disease 2019 (COVID-19) which is caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), was first detected in Wuhan, China in December 2019. Until 4 November 2021, the pandemic COVID-19 has surpassed 248 million cases and 5 million deaths worldwide (1) with an estimated reproduction number or R_0 value of 1.70 ($SD = 0.57$) (2). The total deaths due to COVID-19 have surpassed those of the Middle East respiratory syndrome (MERS) and severe acute respiratory syndrome (SARS), and the majority of the dead were elderly with history of comorbidities such as hypertension, diabetic, obese, and heart disease (3). Many countries implemented non-pharmaceutical interventions that include contact tracing, quarantine and isolation, universal lockdowns, closure of borders, schools and workplaces, physical distancing, and mask-wearing mandate, with varying effects due to different levels of compliances (4, 5). Although COVID-19 vaccination programs have been initiated since the end of December 2020 (6), the rapid emergence of SARS-CoV-2 variants of concern increased the complexity of controlling the disease (7, 8).

As of October 15, 2021, Malaysia had recorded 2,377,033 COVID-19 cases and 27,770 deaths and had the highest case fatality rate (as of September 2021) in Southeast Asia with 80.3 deaths per 100,000 cases (9). Malaysia experienced its first wave of COVID-19 cases from January 25 to February 16, 2020, with only 22 imported and local cases (10, 11). The second wave of the pandemic from February 27 till end of August resulted 9,340 confirmed cases and 127 deaths (12), which were mainly due to a religious mass gathering of an estimated 14,500 local and 1,500 overseas attendees in Sri Petaling, Selangor from February 27 to March 3, 2020 (10, 13, 14). A nationwide movement control order (MCO), which was a partial lockdown, was enforced from March 18, 2020, and subsequent conditional (CMCO) and the recovery MCOs (RMCO) successfully reduced cases and deaths (12). Malaysia experienced zero cases during the period of July 1, 2020 (15).

Studies on the spatiotemporal spread of diseases measure the diffusion and density of disease transmission. Identification of the spatiotemporal pattern and ability to predict the spread enables policymakers to plan mitigation strategies. A spatiotemporal study in China tracked the spread of COVID-19 from Wuhan city, to the Grand Bay Area to the east (16). In Brazil, COVID-19 was first detected in São Paulo with subsequent spread to the north of Brazil, estimation of deaths clustered 1 month before cases and took 17.3 and 32.3 days to reach 50 cases and deaths, respectively (17). A spatial extension of clusters ranging from 0.02 to 2 square kilometer and temporal durations of 6–13 days was identified along with 13 significant emerging clusters in Kuwait (18). In India, the COVID-19 case clustering tendency in 60 districts of western part of the country was observed using hotspot analysis (19).

In Malaysia, many studies have been done that described the characteristics and trend of the COVID-19 epidemic (20), which evaluates the effectiveness of the movement control orders (21), and response and other countermeasures (13, 14). However, studies on spatiotemporal distribution of COVID-19 in Malaysia are scarce. The few studies available were limited to analysis of spatiotemporal pattern of cases using monthly (22) or biweekly data at district level (23). Other studies examined state-level variations in cases and their interactions with air pollutant concentrations (24), or described epidemiological indicators by subregion (25). Spatiotemporal pattern analysis of disease transmission is vital in measuring the spatial dynamics of the epidemic for monitoring its occurrence, intensity, and direction of transmissibility. In this study, we investigated the spatiotemporal clustering pattern of COVID-19 cases in Malaysia specifically the district-level daily spatial autocorrelation of COVID-19 cases and identified spatiotemporal clusters of COVID-19 in Malaysia. The findings of this study could be used as a reference in preparation for similar outbreaks in the future.

MATERIALS AND METHODS

Study Area and Period

Malaysia is the 6th highest populated country in Southeast Asia with an estimated population of 32.37 million in 2020 (26). Geographically, it is situated adjacent to the equator and consists of two major landmasses, Peninsular Malaysia to the west and Sabah and Sarawak (in Malaysian Borneo) to the east of the South China Sea. We included the study period from January 25, 2020 to February 24, 2021, 1 day before national vaccination program was initiated.

Data Collection

This study was a retrospective cross-sectional study using district-level COVID-19 cases data in Malaysia. There is a total of 155 districts throughout the country. The base map of year 2019 and mid-year population data were obtained from the Department of Survey and Mapping Malaysia and the Department of Statistics Malaysia, respectively. The map and population were prepared based on the latest list of districts in the Malaysian COVID-19 open data GitHub repository (27). The base map was modified to accommodate 13 newly redelineated districts (Pokok Sena, Bagan Datuk, Kalabakan, Telupid, Beluru, Bukit Mabong, Kabong, Pusa, Sebauh, Tebedu, Telang Usan, Subis, and Tanjung Manis) using QGIS software v3.8. Data on confirmed COVID-19 cases and mortality were obtained from the same GitHub repository (28, 29). The definition of confirmed COVID-19 cases in this study is cases that were tested positive by real-time polymerase chain reaction (RT-PCR) (28). We analyzed the data at the district level. The federal territories of Putrajaya, Kuala Lumpur, and Labuan were treated as three distinct districts. We used current day and retrospective 7-day cumulative cases as the daily reported cases to account for the median incubation period of COVID-19 (30).

The Spatial Autocorrelation Model

Global Moran's I spatial autocorrelation was utilized to determine whether COVID-19 cases were randomly distributed or clustered daily (31). The Moran's I index ranges from −1 to +1, where positive and negative values indicate positive and negative spatial autocorrelation, respectively, and 0 indicates

spatial randomness. Neighbor weighting based on first-order queen contiguity was applied, which considers districts sharing common border as neighbors. Standardization of the weighting for common border is not applied, as this would introduce bias information to the districts that have more (or less) of common borders due to the size and shape of their district borders as compared to the rest. Langkawi and Labuan were excluded from the analysis as they are islands with tight border controls and require different measures of weight matrix.

The Local Indicator of Spatial Association (LISA) was also examined to identify the daily local spatial association of COVID-19 cases (32). Spatial association of neighboring districts was categorized as positively correlated with similar values (high-high, low-low) or negatively correlated with dissimilar value (high-low, low-high). Statistical significance of the spatial associations was tested using randomization based on 999 permutations ($p < 0.05$). We used the package "spdep" to calculate daily Global Moran's I in R software version 4.0.2, and the package "pygeoda" to obtain Local Moran's I statistics in Python.

The Space-Time Scan Analysis

In addition to Moran's statistics, spatiotemporal heterogeneity of COVID-19 cases was also assessed using space-time scan statistics in SaTScan^{TM} v9.6 (33). The space-time scan statistic utilizes a cylindrical scanning window which has a circular geographical base and whose height corresponds to time (33). The base of the cylindrical window is centered at the centroids of the districts, whereas the height of window varies according to the user-defined study period. During a scan, the window is moved through space and time, which generates numerous cylinders varying in size and height, each reflecting a possible cluster. Then, probability models are used to determine the likelihood of finding cases within the window over the probability of finding cases outside it. The likelihood function for each window is calculated, and the size of the window restricted to a maximum of 50% of the population at risk to determine the maximum spatiotemporal cluster throughout the study period. In this study, the Poisson probability model was applied. The significance of each window–cluster was obtained through 999 iterations using Monte Carlo simulation. The temporal cluster size was set to "day." No geographical overlap was used as criteria for reporting secondary clusters. The datasets were prepared in three files: the confirmed case file, the population by district, and the geographic coordinates for the centroids of each district.

Throughout the study period, high peak of cases occurred after the end of September 2020 (**Figure 1A**). Hence, we divided the study period into two, (1) period of first case until February 24, 2021 and (2) period of first case until 1 day before earliest cluster date in period 1. The second period is to identify the smaller clustering events before the surge of cases after September 2020.

RESULTS

A total of 291,774 confirmed COVID-19 cases and 1,093 COVID-19 deaths were reported from January 25, 2020 to February 24, 2021. Total daily cases and total daily mortality (**Figure 1A**) increased sharply after September 2020 initiating the third wave of the pandemic in Malaysia. The daily Moran's I value fluctuated across this time period, with positive spatial autocorrelation above 0.3 ($p < 0.05$, permutation of 999) (**Figure 1B**). The higher Moran's I value above 0.5 ($p < 0.05$, permutation of 999) was reported in March, September, October, and November (**Figure 1B**; in red), which were also the initial period of second and third waves. The highest incidence rate over the period was observed in Sepang (2,920.93 cases per 100,000) and Klang (2,668.72) in Selangor, the state with highest population (**Figure 1C**), followed by Putatan in Sabah (2,325.58), Jelebu in Negeri Sembilan (2,212.25), and Kulai (2,189.96) in Johor. Sabah districts constituted half of the top ten districts with the highest incidence rate (**Figure 1D**). The states with the highest mortality rate were Selangor (146.59 COVID-19 deaths per 100,000), Labuan (145.49), Kuala Lumpur (137.65), and Negeri Sembilan (110.86) (**Figure 1E**).

The daily district-level local spatial autocorrelation analysis showed the dispersal of high-risk clusters from small area to larger extent. In the initial period of 4 months from January to April 2020, the COVID-19 cases were reported in all states, but the highest in Selangor (1,432 cases), Kuala Lumpur (1,232), and Johor (663) (**Figure 2**). Most cases were reported after middle of March 2020. Since the COVID-19 cases first detected on January 25, 2020, the initial high-high cluster was observed in Petaling in Selangor and Kuala Lumpur on February 4 (**Figure 3**). The clusters expanded to four surrounding districts in Selangor (Hulu Langat, Gombak, Sepang, and Kuala Langat) and Putrajaya on March 3, 2020, subsequently further included the neighboring state, Seremban in Negeri Sembilan on March 6, 2020 and Bentong in Pahang on March 11, 2020 (Moran's I: 0.54, $p < 0.05$) (**Figure 3**). On March 14, the high-high cluster in Selangor was reduced to only one district (Hulu Langat), but started to move south (Tampin, Negeri Sembilan; Alor Gajah, Melaka). Within 2 weeks, the high-high cluster had covered a larger area of nine districts in several states in the south of Peninsula Malaysia (Kota Tinggi, Batu Pahat, Pontian and Kulai, Johor; Seremban and Kuala Pilah, Negeri Sembilan; Batang Padang, Perak; Petaling and Sepang, Selangor) (**Figure 3**). Four days later, the high-high cluster included 12 districts with the addition of three districts (Mersing and Segamat, Johor; Kuala Pilah, Negeri Sembilan). From the middle to end of April, Sarawak had a high-high cluster in two districts (Asajaya and Serian), which subsequently expanded to three adjacent districts (Samarahan, Simunjan and Kuching), whereas Selangor experienced a reduction in cases (**Figure 3**).

In the subsequent 3 months from May to July 2020, the total number of cases remained below 100 for all states except Kuala Lumpur (1,245 cases), Selangor (690), Negeri Sembilan (516), and Sarawak (171) with minor fluctuation (**Figure 2** and **Supplementary Figure S1**). On May 23, high-high cluster was reported in more neighboring districts of Selangor including

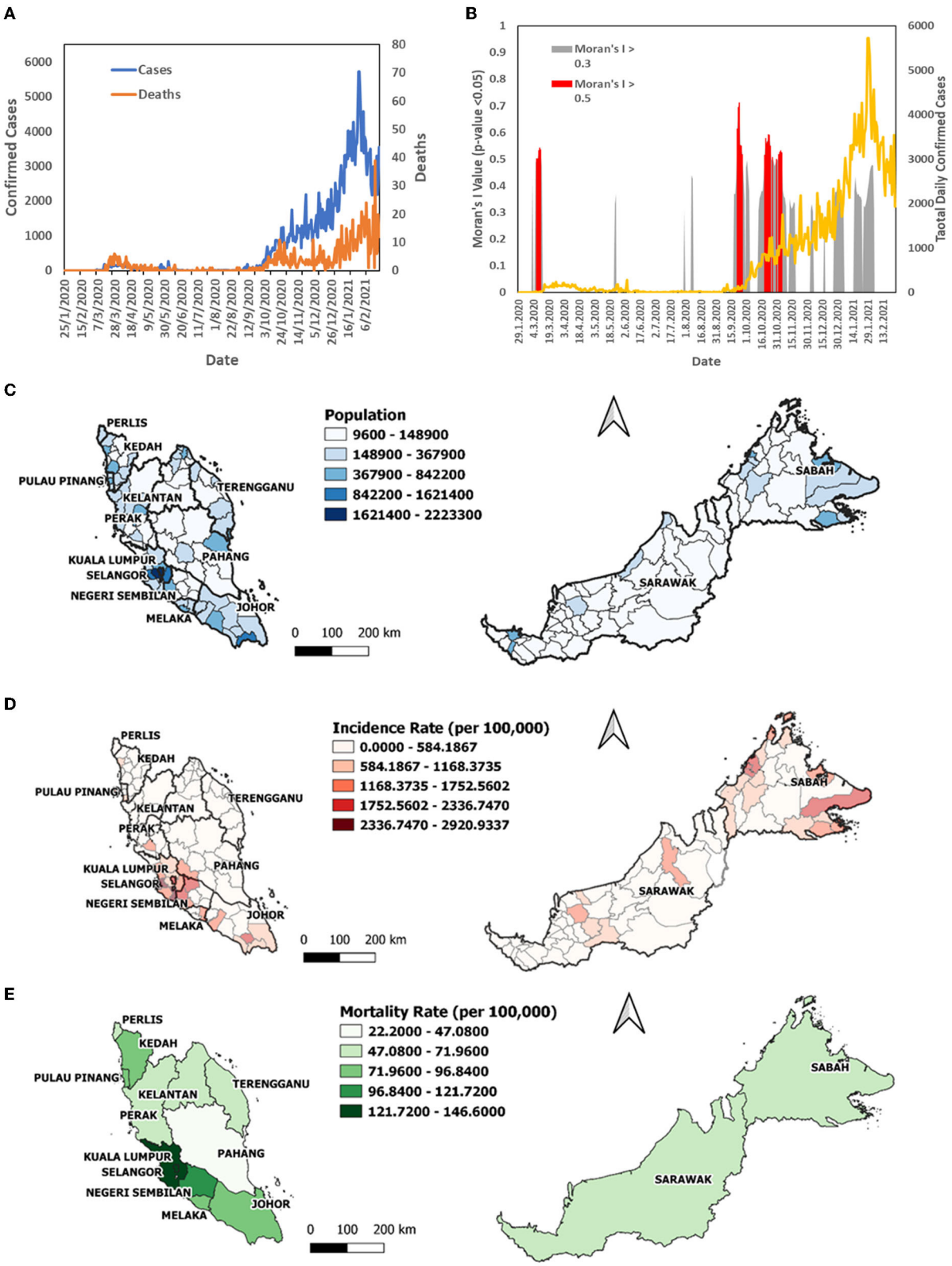

FIGURE 1 | The COVID-19 case profile in Malaysia from January 25, 2020 to February 24, 2021; **(A)** total daily confirmed cases, daily mortality; **(B)** Moran's *I* >0.5 over the same period; **(C)** map of population by district; **(D)** map of incidence rate per 1,00,000 population by district; **(E)** map of mortality rate per 1,00,000 population by state.

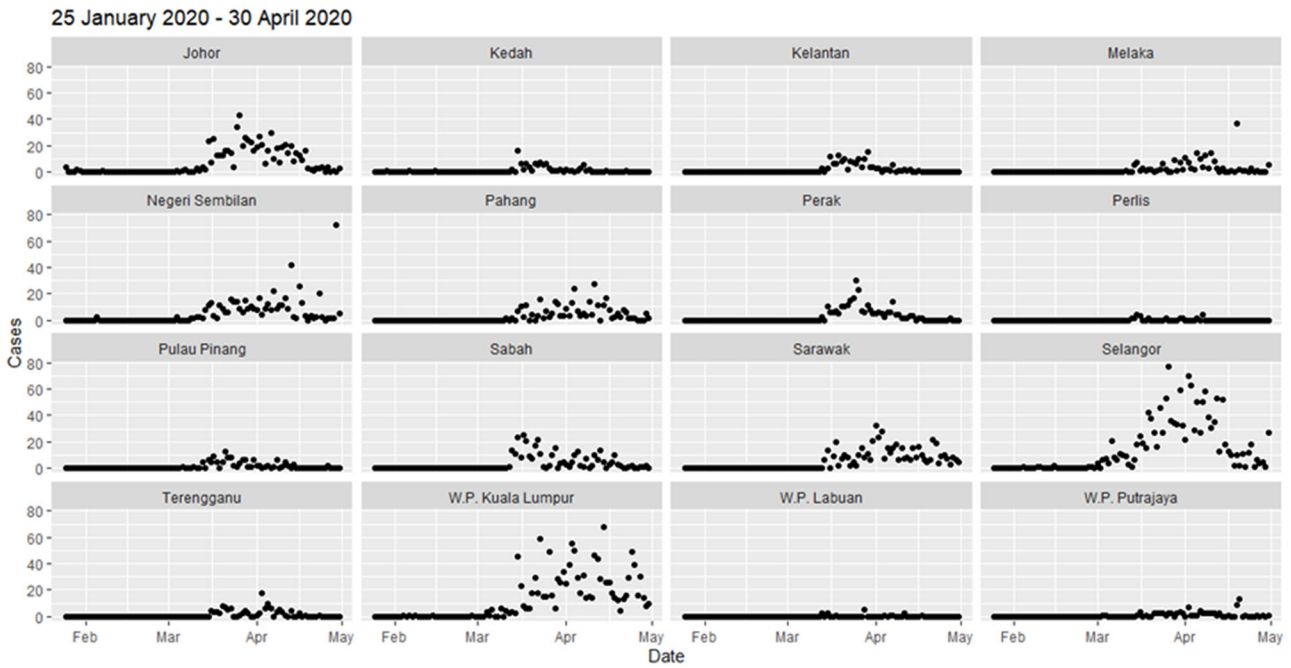

FIGURE 2 | Total COVID-19 new cases by state from January 25, 2020 to April 30, 2020.

Bentong in Pahang and Seremban in Negeri Sembilan, with total of 9 districts (**Supplementary Figure S2**). The number of districts in the high-high cluster reduced to six and was situated only in Negeri Sembilan and Melaka on 16 June. Till the end of July (July 29), west Sarawak (Samarahan, Lundu, Kuching, Serian) and Perlis showed a high-high cluster.

From August to October 2020, clusters of COVID-19 cases were observed in the north of Peninsular Malaysia and in East Malaysia. Sabah experienced extremely high spikes in cases (total cases of 14,650) toward the end of October, whereas cases fluctuated in Kedah (2,015), Selangor (2,577), and Pulau Pinang (873) (**Figure 4**). A total number of cases in Selangor in August–October were three times higher than in May–July. In early August, the high-high cluster was concentrated in the northern Peninsular (Padang Terap, Kubang Pasu, Kedah; Perlis) (**Figure 5**). On August 22, 2020, the neighboring districts and states (Kuala Muda, Sik, Baling and Kulim, Kedah; Timur Laut, Barat Daya and Seberang Perai Utara, Pulau Pinang) became a high-high cluster. In the East Malaysia, high-high cluster was observed initially at east of Sabah (Kinabatangan) on September 1, 2020 and expanded to the neighboring districts (Lahad Datu, Semporna, Kunak, and Tawau) by September 21, 2020 (**Figure 5**). On October 7, 2020, the high-high clusters expanded from the east to the west (Penampang) of Sabah. After 12 days, the situation in Sabah worsens with the high-high clusters at eight districts in the west (Kota Kinabalu, Kota Belud, Tuaran, Tambunan, Papar, Ranau, Penampang, and Putatan) and three districts in the east (Semporna, Kunak, and Tawau). On October 22, 2020, one additional district (Kinabatangan, Sabah) was added to the high-high clusters (Moran's $I = 0.57$, $p < 0.05$). From November 1 till February 24, 2020, the high-high clusters scattered throughout Malaysia (**Supplementary Figure S3**). Selangor ranked highest in total cases (92,121 total new cases, 35.4%), followed by Sabah (37,325, 14%), Johor (33,864, 13%), and Kuala Lumpur (31,132, 12%) (**Supplementary Figure S3**). Selangor, Johor, and Kuala Lumpur showed an increasing trend, but in Sabah, total number of new cases gradually decreased. The Sabah's high-high cluster subsided in the east by November 13, 2020, but persisted in the west until January 29, 2021.

Space-time scan was applied to two temporal period, (1) period of initial cases until introduction of vaccine and (2) period of initial cases until 1 day before initial cluster date in period 1. In the first period, a main cluster was detected with a radius of 178.8 km (RR = 11.93; $p < 0.001$; log-likelihood ratio 1344194.72), which spanned the following districts: Jasin, Melaka Tengah, Alor Gajah in Malacca, Tampin, Rembau, Kuala Pilah, Jempol, Port Dickson, Seremban, Jelebu in Negeri Sembilan, Muar, Batu Pahat, Kluang in Johor, Bera, Rompin in Pahang, Sepang, Kuala Langat in Selangor, Kuala Lumpur, and Putrajaya, from November 24, 2020 to February 24, 2021 (**Figure 6**, **Table 1**). A secondary cluster was also detected, comprised of 23 districts in Sabah with a radius of 218.77 km (RR = 5.31; $p < 0.001$; log-likelihood ratio 259019.17) from October 9, 2020 to February 8, 2021.

Three clusters were identified by space-time scan in the period 2 (**Figure 6**, **Table 1**). The main cluster was 50.12 km radius (RR = 9.37; $p < 0.001$; log-likelihood ratio 34647.832418), which encompasses the districts of Seremban, Port Dickson, Rembau,

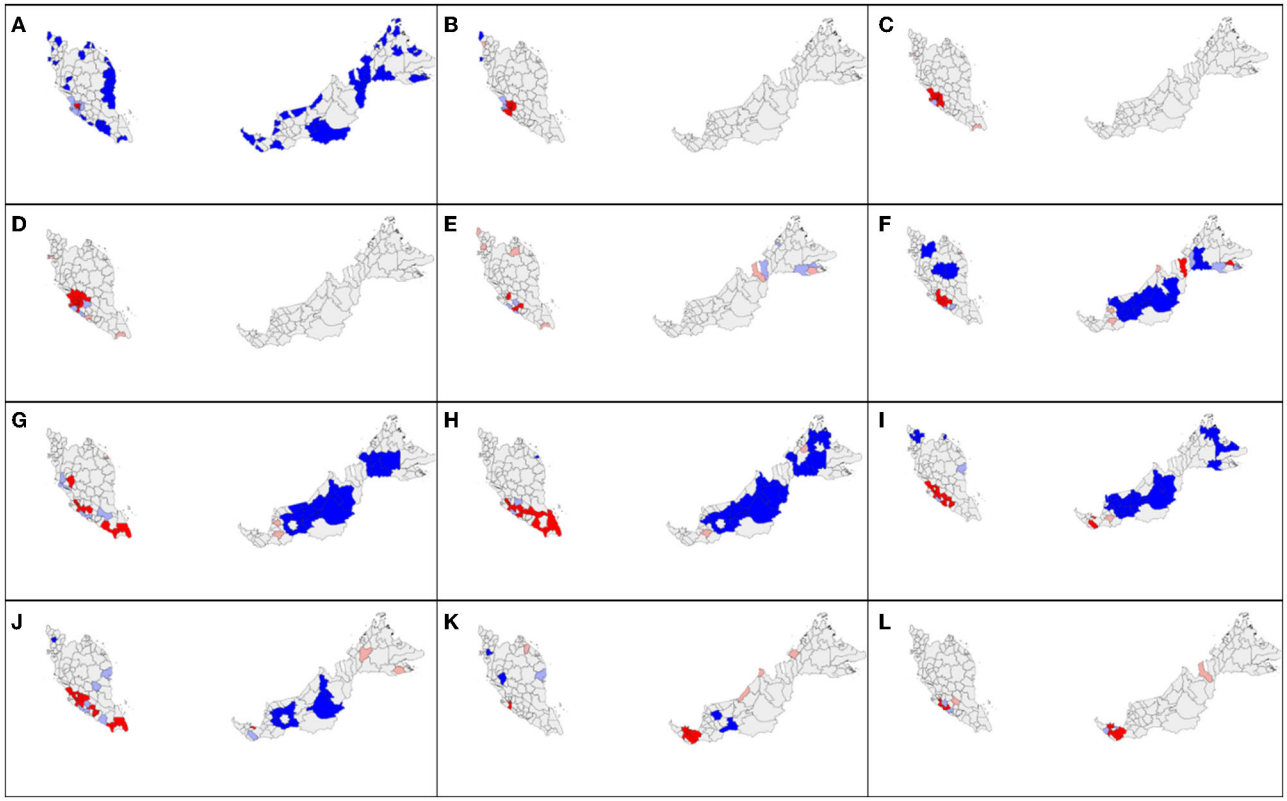

FIGURE 3 | Spatial autocorrelation distribution of COVID-19 new cases by district in Malaysia at cumulative sum of current and 7 days retrospectively in 2020 on **(A)** February 4; **(B)** March 3; **(C)** March 6; **(D)** March 11; **(E)** March 14; **(F)** March 17; **(G)** March 26; **(H)** March 30; **(I)** April 12; **(J)** April 15; **(K)** April 21; **(L)** April 30. Red color indicates high-high cluster, pink indicates high-low, blue indicates low-low, and light blue indicates low-high cluster.

Jelebu, Kuala Pilah in Negeri Sembilan, Putrajaya, Sepang, Hulu Langat, Kuala Langat in Selangor, and Kuala Lumpur from March 16, 2020 to June 10, 2020 for more than 3 months, the population at risk of which is 4.7 times of population in the secondary cluster. The secondary cluster was 56.74 km radius in Kunak, Tawau, Semporna, Lahad Datu in Sabah (RR = 41.73; $p < 0.001$; log-likelihood ratio 32512.96) from September 8, 2020 to October 8, 2020 within 1 month. The third cluster was concentrated in Kota Setar, Kedah from October 2 to 8, 2020 (RR = 170.11; $p < 0.001$; log-likelihood ratio 20283.69).

DISCUSSION

In this study, we used R script to obtain the spatial autocorrelation of 374 time points (January 25, 2020–February 24, 2021) for 155 districts and three federal territories in Malaysia. Significant global Moran's I indices above 0.5 were observed in the initial periods of the second and third waves implying an impending outbreak. The daily local indicators of spatial autocorrelation depicted the disease spread dynamics in Malaysia across districts. Space-time clusters obtained from space-time statistics confirmed the high-risk areas identified using local Moran's I. Both daily Moran's I and number of high-high district clusters could be used as additional indices for monitoring COVID-19 spatiotemporal transmission intensity. A higher Moran's I value indicates that cases are clustered in an area that may potentially result in an outbreak to the residents in and surrounding the area.

Global Moran's I value above 0.5 ($p < 0.05$) was observed in the initial period of the outbreak (**Figure 1B**). Moran's I value first peaked above 0.5 during March 7 and 11, 2020 preceding a surge of COVID-19 cases in Selangor, Kuala Lumpur, and Putrajaya. This surge was due to a mass religious convention held in Kuala Lumpur from February 27 to March 3, 2020 (14), which resulted in the second wave of cases from February 26, 2020 to June 30, 2020 (23) in Malaysia. The second and third peaks of Moran's I values were in mid-September and end of October to early November, 2020, which also preceding a surge of COVID-19 cases of the third wave of COVID-19 in Malaysia. These values informed the spatial dynamics of the initial outbreak, in addition to the incidence rate and time-varying reproduction number (25).

The daily local spatial autocorrelation (LISA/local Moran's I) was able to measure the dynamics and intensity of the spatial spread of disease based on population at risk. Similar measures of spatiotemporal spread have been assessed in other countries, such as China (16), Italy (34), and Russia (35). In Malaysia, initially from January 25 to April 30, the spread of COVID-19

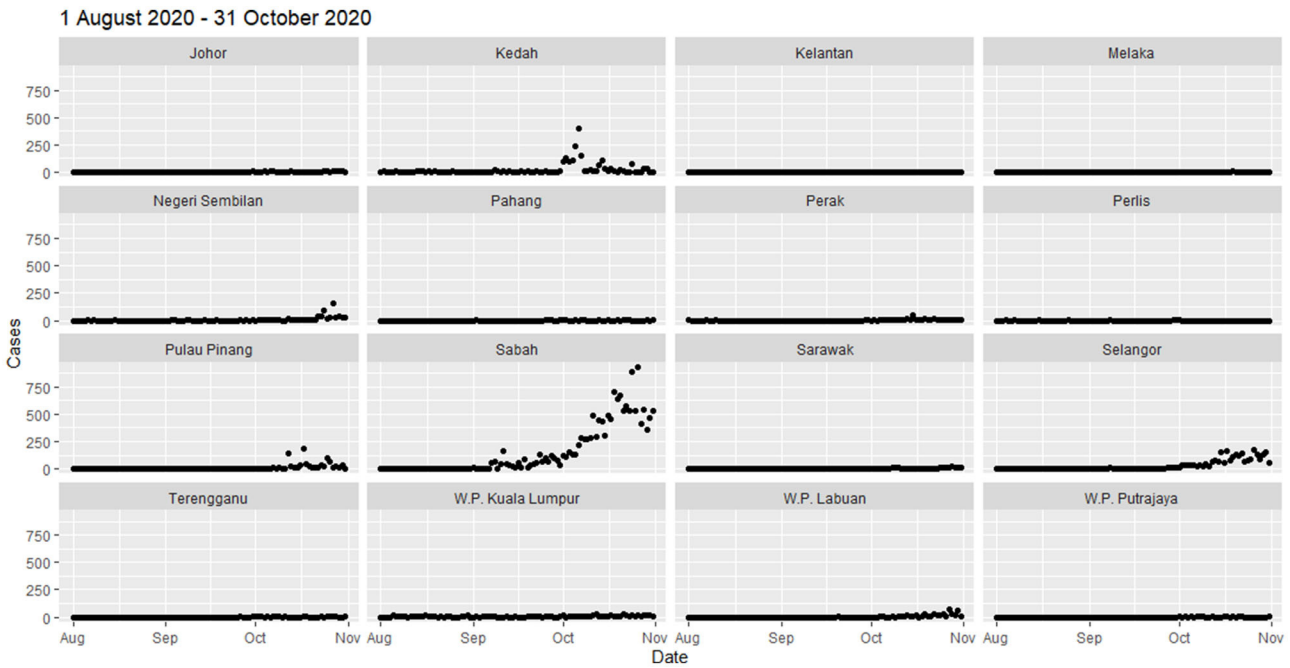

FIGURE 4 | Total COVID-19 new cases by state from August 1 to October 31, 2020.

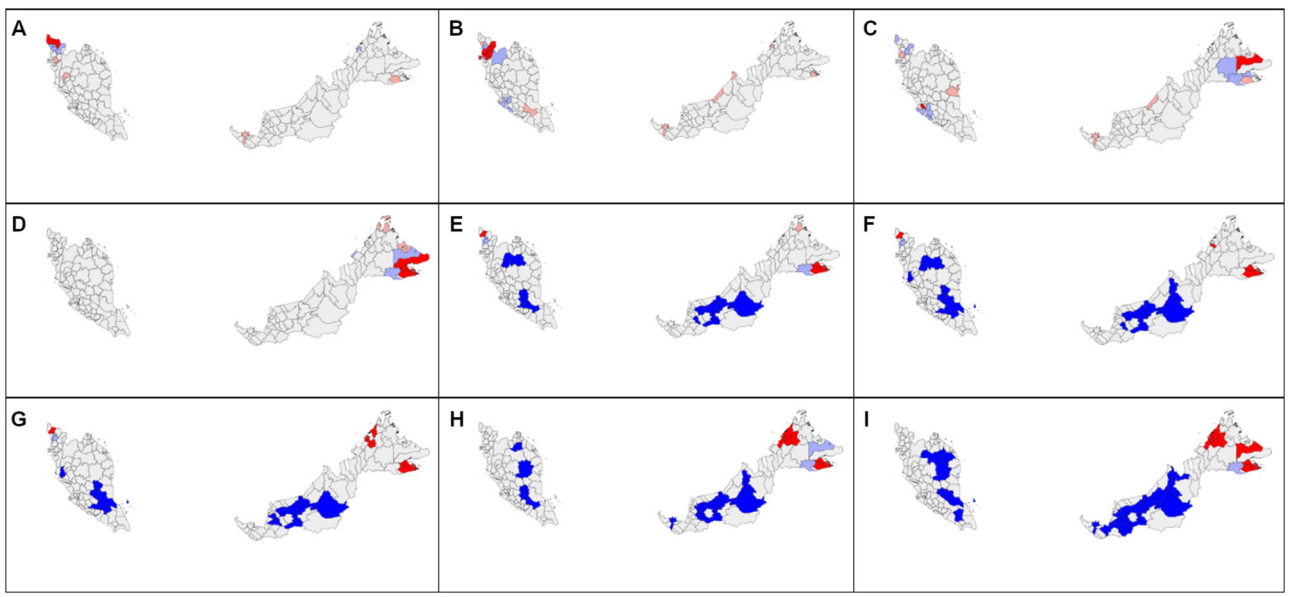

FIGURE 5 | Spatial autocorrelation distribution of COVID-19 new cases by district in Malaysia at cumulative sum of current and 7 days retrospectively in 2020 on **(A)** August 5; **(B)** August 22; **(C)** September 1; **(D)** September 21; **(E)** October 5; **(F)** October 7; **(G)** October 8; **(H)** October 19; **(I)** October 22. Red color indicates high-high cluster, pink indicates high-low, blue indicates low-low, and light blue indicates low-high cluster.

high-high cluster of new cases started in Selangor and Kuala Lumpur in the mid-west peninsular Malaysia on to the south and then west of Sarawak. The high-high cluster in Selangor receded after July 2020. From May 1 to July 31, high-high clusters were mainly reported in Selangor, Kuala Lumpur, Negeri Sembilan, Johor, and Sarawak. In early August, the spatial autocorrelation high-high cluster initiated in Kubang Pasu, Kedah was traced to an index case with the super spreader strain D614G, that spread to neighboring Perlis and Pulau Pinang state called the Sivagangga cluster (36). The high-high cluster in Sabah can be traced to an outbreak in a police detention center in Lahad Datu, Sabah known as the Benteng Lahad Datu cluster with total

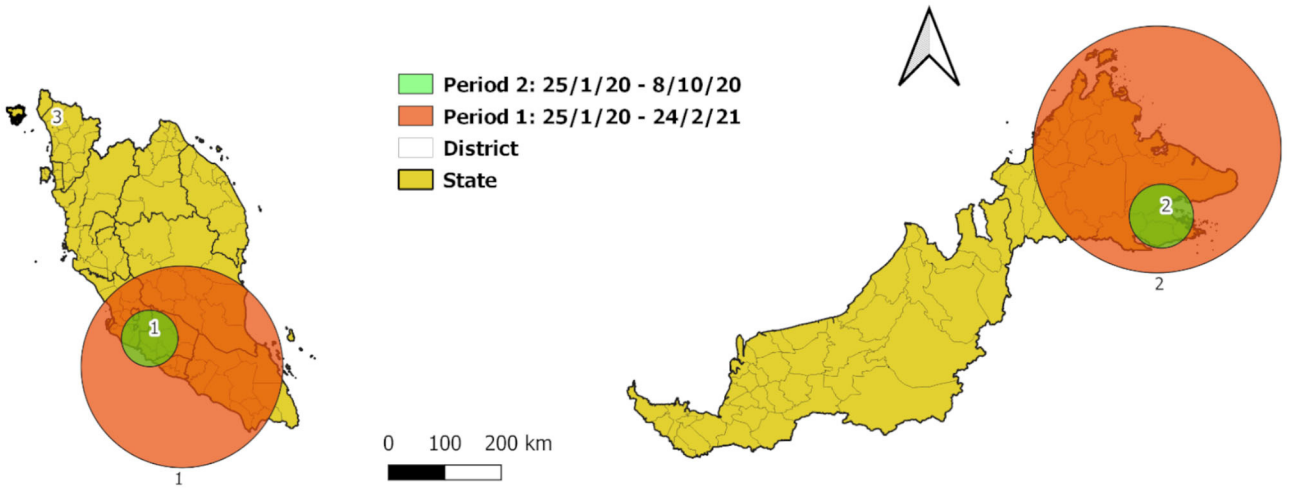

FIGURE 6 | Spatial scan statistic of COVID-19 new cases by district in Malaysia at cumulative sum of current and 7 days retrospectively from January 25, 2020 to February 24, 2021.

TABLE 1 | Space-time clusters of COVID-19 cases from January 25, 2020 to February 24, 2021 at the district level.

Cluster	Duration (days)	Observed	Expected	RR	LLR	# Of districts	Population at risk
Period 1: January 25, 2020–February 24, 2021							
1*	2020/11/24–2021/2/24	1156183	210343.49	11.93	1344194.72	36	15,487,800
2*	2020/10/9–2021/2/8	324500	70564.82	5.31	259019.17	23	3,928,500
Period 2: January 25, 2020–October 8, 2020							
1*	2020/3/16–2020/6/10	29302	4404.23	9.37	34647.83	10	4,896,200
2*	2020/9/8–2020/10/8	12108	333.79	41.73	32512.96	4	1,041,400
3*	2020/10/2–2020/10/8	4930	30.64	170.11	20283.69	1	423,400

RR, relative risk; LLR, log-likelihood ratio.
$^{*}p < 0.05$.

contact cases of 1,146 (11), which affects neighboring districts that include Tawau, Sandakan, Kinabatangan, and Tuaran. Since September 14, 2020, the high-high cluster in Sabah had expanded from two districts to five in 8 days. After the Sabah state elections were held on September 26, 2020, cases surged exponentially and the high-high cluster increased to 12 districts, from the east coast to the western part of Sabah. This may be attributed directly (70% of cases within Sabah) or are spillover effects (64.4% of cases in the rest of Malaysia) of the Sabah election (37). The total number of cases in the period of August to October 2020 was 7.6 times the figure 3 months before. From November 2020 to 24, February 2021, the high-high clusters shifted from Sabah to Selangor and Negeri Sembilan, then to Pahang, Johor, and Sarawak. Phylogenetic analysis of new B.1.524(G) lineages support claims that the cases in Selangor came from Sabah (38).

Spatiotemporal clustering obtained using space-time scan statistics provided additional information on the dispersal of the disease. The cluster with the highest relative risk was RR = 11.93, in the southwest of peninsular Malaysia, that is, the districts in the cluster had 11.93 times the risk of COVID-19 compared to districts outside the cluster in the same period, with 15,487,800 population at risk (nearly half of the population in Malaysia). Space-time scan statistical analysis has been widely utilized to study other diseases such as dengue, zika, MERS (39–41). Previous studies using space-time scan for COVID-19 discovered that Hubei province has higher risk than the other region in China (42) whereas a Korean study found higher risk in Daegu City than neighboring province (43). A retrospective spatial scan study in Southeast Asia during January 13, 2020 and March 16, 2020 further confirmed that Malaysia and Singapore were the most likely cluster between March 4–March 16, 2020 (RR = 72.07, LLR = 1910.08, $p < 0.001$) (44). The most likely cluster for the period 2 (January 25 to October 8, 2020) consisted of Negeri Sembilan, Putrajaya, Kuala Lumpur, and Selangor (10 districts) in this study correlates with a state-level spatial scan analysis study in Malaysia (45).

Identifying the areas with high spatial clustering of cases assists in public health control measures. The spatial autocorrelation analysis showed that COVID-19 is highly likely to have similar high number of cases at the adjacent districts. Significant spatial association of COVID-19 cases was also discovered in neighboring region in China (46). It

is indisputable that cross-boundary transmission may occur across administrative boundaries in short period. The analysis could be used as a tool for decisions on shrinking and expanding movement control boundaries. Space-time scan statistics analysis exhibited the connection of daily clusters in space and time with a flexible window setting, but is restricted to the shape of the scanning window and might include neighboring low case districts that fall in the buffer area. Whereas, local Moran's I is able to delineate the neighboring cluster and is not limited to the shape of a scanning window. Whereas, in this study, we focused on daily local Moran's I, Hohl et al. (47) were able to detect emerging clusters using daily prospective space-time scan statistic. Both spatial autocorrelation and scan statistics could be taken as reference as they complement each other (48, 49). Analysis at smaller units of aggregation, such as sub-district or residential area, will better reflect the real-time local clustering events, and thus, smaller area public health data need to be made available in setting geographical policy. Therefore, understanding the spatiotemporal clustering situation could provide valuable information in measuring the disease dispersal pattern and intensity of an epidemic.

Our study has several limitations. First, for Moran's I and LISA analysis, the irregular shapes of the districts affected the weight matrix of the spatial autocorrelation. This issue can only be resolved using regular spatial grids and aggregation of the address or point-level data. Second, we could not perform spatial autocorrelation analysis on the number of deaths by districts as the open-source data on COVID-19 deaths were limited only to state level. Without these data, the interaction and dynamics of the cases and deaths could not be elucidated from the spatiotemporal perspective. Third, there may be underreporting of cases; nevertheless, the clustering effect revealed the underlying risk of the transmission. Fourth, there is the well-known modifiable areal unit problem (MAUP) which occurs when using aggregated data that thwarts obtaining consistent results with different spatial analysis levels. Future research is suggested to conduct multiscale and multizonal system analyses to address this problem (50).

CONCLUSION

In conclusion, we were able to estimate the spatiotemporal trend of COVID-19 in Malaysia from January 25, 2020 to February 24, 2021 using Moran's I index and space-time scan statistics. Daily monitoring of these indicators could be useful additional information for public health managers to assess the spatiotemporal risk of the epidemic. This analysis can also be used in real-time monitoring of the outbreak. For epidemic spread and density forecasting, both analyses need to be in smaller spatial and time units to enable prospective estimation of potential outbreaks. Future studies are needed to study the spatiotemporal variation of Rt values in determining the correlation of transmission and preventive measures and to compare the cluster patterns obtained in this study with those using advanced Bayesian spatiotemporal models and machine learning spatial modeling.

DATA AVAILABILITY STATEMENT

Publicly available datasets were analyzed in this study. This data can be found at: https://github.com/MoH-Malaysia/covid19-public.

AUTHOR CONTRIBUTIONS

YC, KL, SM, MC, and NM contributed tremendously to the production of this manuscript. QR managed and cleaned the data. CK, FL, and BG reviewed and gave technical advisory to the manuscript and contributed essential revisions. All authors have read and approved 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.2022.836358/full#supplementary-material

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What "Family Affair?" Domestic Violence Awareness in China

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Introduction: Domestic violence is toxic to society. With approximately one in three women on average falling victim to domestic violence, systematic solutions are needed. To further complicate the issue, mounting research shows that COVID-19 has further exacerbated domestic violence across the world. Situations could be even more pronounced in countries like China, where though domestic violence is prevalent, there is a dearth of research, such as intervention studies, to address the issue. This study investigates key barriers to domestic violence research development in China, with a close focus on salient cultural influences.

Methods: A review of the literature on domestic violence in China in PubMed, PsycINFO, and Scopus was conducted to answer the research question. The search was focused on three themes, domestic violence, China, research, and cultural influences.

Results: The study findings show that categorizing domestic violence as a "family affair" is a key barrier to domestic violence research development in China—an incremental hindrance that prevents the public and policymakers from understanding the full scale and scope of domestic violence in China. In addition to abusers, witnesses, and victims, even law enforcement in China often dismisses domestic violence crimes as "family affairs" that resides outside the reach and realm of the law. The results indicated that mistreating domestic violence crimes as "family affairs" is a vital manifestation of the deep-rooted cultural influences in China, ranging from traditional Confucian beliefs in social harmony to the assumed social norms of not interfering with other people's businesses.

Conclusion: Domestic violence corrupts public health and social stability. Our study found that dismissing domestic violence cases as "family affairs" is an incremental reason why China's domestic violence research is scarce and awareness is low. In light of the government's voiced support for women's rights, we call for the Chinese government to develop effective interventions to timely and effectively address the domestic violence epidemic in China.

Keywords: domestic violence, COVID-19, china, family affairs, public health, interventions

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INTRODUCTION

Domestic violence is toxic to society. Domestic violence or violence against women could be understood as "any act of gender-based violence that results in, or is likely to result in, physical, sexual, or mental harm or suffering to women, including threats of such acts, coercion or arbitrary deprivation of liberty, whether occurring in public or in private life" (1). Domestic violence not only has a devastating effect on personal and public health, it is also a constant threat to social stability and global solidarity (2). On an individual level, mounting research shows that domestic violence could result in long-term damages to people's physical and psychological health (3–8). On a global level, data from the World Health Organization show that one in every three women falls victim to domestic violence (2).

However, due to a lack of research, there is a shortage of up-to-date and systematic investigations of domestic violence in developing countries. What is clear, though, is that currently available research paints a dire picture. A systematic review study that pooled all published papers conducted in low- and middle-income countries indicates that, for instance, lifetime intimate partner violence against women was as prevalent as 55% (9). Additional compounding factors are also present. As seen amid the pandemic, partially due to issues such as prolonged time spent with the abusers, deteriorated financial stability, and disrupted local and national support programs, COVID-19 has further exacerbated domestic violence worldwide (10–12). In the early days of the pandemic, for instance, police records show that in Jianli city, Hubei Province, China, there was a three-fold hike of domestic violence cases influenced heavily by the pandemic and its prevention measures (e.g., lockdowns) (13).

While similar trends are also present in developed countries, what is unique about domestic violence in countries like China is that the victims often face the dual burden of lack of systematic awareness at the societal level (i.e., dearth of timely and quality research) and have limited timely and systematic support from society. Traditionally, a key solution to address domestic violence has been via effective intervention programs, ranging from researchers-led programs, non-profit organizations initiated support groups, local government-sponsored hotlines, or state-funded safe houses (14). However, these interventions are often poorly developed in countries such as China (15), where there is a pronounced dearth of research on domestic violence and a lack of solutions to which victims could turn for help. In other words, though domestic violence's prevalence in China has long been established —similar if not worse than the global average (i.e., 34%) (16), domestic violence research and interventions in China are often rudimentary and of suboptimal priority (17).

This lack of priority is also reflected in police officers' attitudes toward domestic violence cases in China. In a study on 623 police officers in China, for instance, researchers found that nearly half of law enforcement personnel (i.e., 46.5%) are likely to not make arrests of domestic violence abusers, regardless of the severity of the violence (18). These insights combined, overall, further underscore the imperative for in-depth and comprehensive research on domestic violence in China, which in turn, could raise the awareness of domestic violence across society and help government and health officials to develop evidence-based intervention programs to eliminate, if not eradicate, domestic violence in China. However, to date, there is a dearth of investigations on factors that negatively influence the research development on domestic violence in China, particularly in light of the unique insights exposed by the COVID-19 pandemic (15). Thus, to bridge the research gaps, this study aims to examine the key barriers to domestic violence research development in China, with a close focus on salient cultural influences.

METHODS

A review of the literature on domestic violence research in China in PubMed, PsycINFO, and Scopus was conducted to answer the study question. In the context of this study, barriers to domestic violence research development in China were operationalized as incremental links that prevent the public and the policymakers from understanding the scale and scope of domestic violence in China. While a number of cultural influences and social norms could shape domestic violence in China, we only focused on the most salient factors (e.g., most cited) identified in academic literature. The narrative literature review approach was adopted as the review framework, which could be understood as "an objective, thorough summary and critical analysis of the relevant available research and non-research literature on the topic being studied" (19). One key advantage of the narrative literature review approach is that it could help the researchers gain a structured understanding of the literature in an effective manner (19).

The search was focused on four themes, domestic violence, China, research, and cultural influences. Though domestic violence could happen to both men and women (20), as women are often the predominant gender in domestic violence victims, our study focused on female domestic violence. An example PubMed search term could be found in **Table 1**. The search was first conducted on May 25, 2021, with the follow-up review completed on December 28, 2021. A schematic representation of the research flow could be found in **Figure 1**. Scholarly papers were excluded if they: (1) were not published in English, (2) were not focused on domestic violence research on women, and (3) could not provide key insights on the influences of cultural or social norms on domestic violence in China. To ensure up-to-date insights could be considered to help contextualize the findings and white papers were also reviewed and analyzed.

RESULTS

Of the total number of articles included in the review and subsequent analysis ($N = 21$), the vast majority were published within the last 5 years ($n = 12$), and adopted various methodological approaches. Some of the reviewed studies used qualitative approaches investigated domestic violence in the context of family experiences [e.g., (21)] or a series of interviews with males ($n = 18$) who had used violence against their partner [e.g., (22)]; while others adopted more quantitative

TABLE 1 | Example PubMed search strings.

Theme	Search string
Domestic violence	"Domestic violence"[MeSH] OR "domestic violence"[TIAB] OR "intimate partner violence"[MeSH] OR "intimate partner violence"[TIAB] OR "family violence" OR "violence against women"
Cultural influences	Culture*[MeSH] OR culture*[TIAB] OR attitude*[MeSH] OR attitude*[TIAB] OR norm*[MeSH] OR norm*[TIAB] OR "social norm*" OR "cultural influence*" OR belief*
Research	Research[MeSH] OR Research[TIAB] OR investigation* OR studies OR study OR intervention*
China	China[MeSH] OR China[TIAB] OR Chinese[MeSH] OR Chinese[TIAB]

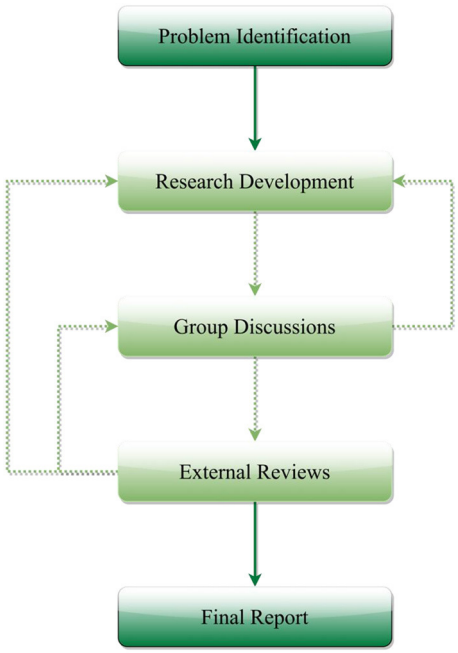

FIGURE 1 | A schematic representation of the research flow.

approaches, such as cross-sectional designs with large groups of participants [e.g., (23, 24)], or a pre-post experimental design with police officers (N=401) in evaluating changing attitudes toward domestic violence [e.g., (25)]. Detailed information on the list of articles reviewed could be found in **Table 2**.

The study findings show that categorizing domestic violence as a "family affair" is a key barrier to domestic violence research development in China—an incremental hindrance that prevents the public and policymakers from understanding the full scale and scope of domestic violence in China. In addition to abusers, witnesses, and victims, even law enforcement in China often dismisses domestic violence crimes as "family affairs" that reside outside the reach and realm of the law [e.g., (36)]. The results indicated that mistreating domestic violence crimes as "family affairs" is a vital manifestation of the deep-rooted cultural influences in China, ranging from traditional Confucian beliefs in social harmony to the assumed social norms of not interfering with other people's businesses [e.g., (27)]. A list of exemplary quotes could be found in **Table 3**.

TABLE 2 | List of articles reviewed.

Author	Year	Title
Chan (22)	2006	The Chinese concept of face and violence against women
Ko Ling et al. (23)	2008	Understanding violence against Chinese women in Hong Kong: an analysis of risk factors with a special emphasis on the role of in-law conflict
Ko Ling (26)	2009	Sexual violence against women and children in Chinese societies
Hayes et al. (25)	2020	Chinese police cadets' attitudes toward domestic violence: a pretest/posttest design
He and Hang Ng (27)	2013	In the name of harmony: the erasure of domestic violence in China's judicial mediation
Jiang (28)	2019	The family as a stronghold of state stability: two contradictions in China's anti-domestic violence efforts
Li et al. (29)	2021	Tolerance for domestic violence: do legislation and organizational support affect police view on family violence?
Lin et al. (18)	2020	Chinese police officers' attitudes toward domestic violence interventions: do training and knowledge of the Anti-Domestic Violence Law matter?
Lin et al. (30)	2021	Rank, experience, and attitudes toward domestic violence intervention: a moderated mediation analysis of Chinese police officers
Lu and Hao (31)	2021	Combating domestic violence during COVID-19: what does the Chinese experience show us?
Qi et al. (32)	2020	Anti-domestic violence law: the fight for women's legal rights in China
Qu et al. (33)	2018	Correlates of attitudes toward dating violence among police cadets in china
Sun et al. (34)	2020	Officer and organizational correlates with police interventions in domestic violence in China
Tsun and Lui-Tsang (21)	2005	Violence against wives and children in Hong Kong
Xie et al. (35)	2017	Domestic violence counseling in rural northern China: gender, social harmony, and human rights
Xu et al. (36)	2020	Empirical study on handling of domestic violence cases by police, China Journal of Social Work
Xue (37)	2008	Perceptions of and attitudes toward domestic violence in China: implications for prevention and intervention
Wang et al. (38)	2019	Correlates of Chinese police officer decision-making in cases of domestic violence
Wang et al. (24)	2021	Officers' preferences for gender-based responding to domestic violence in China
Wu et al. (39)	2020	Organizational support and Chinese police officers' attitudes toward intervention into domestic violence
Zhao et al. (40)	2018	The tendency to make arrests in domestic violence: perceptions from police officers in China

TABLE 3 | Example quotes from the articles reviewed.

Author	Year	Quote
Cao et al. (41)	2016	"Domestic violence in China is traditionally regarded as a **family affair**, thus it is beyond social and governmental concern and beyond the consideration of Chinese modern law".
Chen et al. (42)	2021	"For a longtime, domestic violence has only been regarded as a **family affair**, protected by family privacy and other traditional values; and as a result, it is beyond the social and governmental concern, and beyond the coverage of the modern law until 2016".
Chung et al. (43)	1996	"Moreover, most Chinese believe that a **family affair** is a private matter and other people should not intervene. Some nurses may hold these traditional beliefs and attitudes and this may affect their approach and care to battered women".
Jiang (28)	2019	"In more severe cases, a lot of relatives and friends will show up and take part, trying all-out efforts or even cajole the wives to withdraw their domestic violence reports by brainwashing her with the cliché that 'every couple will fight and quarrel; it is shameful to make **family affairs** public.' Eventually, the wives surrender".
Lau and Chan (44)	2008	"Chinese people with traditional beliefs tend to believe that a family problem is private **family affair** (jia shi) that should not be handled by people".
Li et al. (45)	2020	"Furthermore, domestic violence is considered as a private, often shameful, **family affair** that should not be disclosed to outsiders"
Liu et al. (46)	2018	"On the basis of a series of researches and practice in preventing from IPV [intimate partner violence] in China, a new law on IPV has taken effect. Under the law, IPV is no longer considered a "**family affair**," but a legal issue that demands action from the courts and the police".
Loke et al. (47)	2012	"However, when health professionals hold the cultural belief that **family affairs** are a private matter, this may affect their approach toward women who suffer from intimate partner violence. Even if women seek health care, most people, including nurses, still believe that IPV is a private family matter in which other people should not intervene".
Lu and Hao (31)	2021	"In Chinese culture, domestic violence was once considered a private **family affair** that should not be regulated by the public power".
Qi et al. (32)	2020	"Due to the long-term influence of this traditional system that has emphasized family stability in China, domestic violence has often been tolerated or acquiesced to by government and society, who tend to classify its incidence as an internal **family affair**".
Xu et al. (36)	2020	"Officers who took part in the interviews no longer think that DV was only a **family affair** and generally declared all the cases involving DV would be handled immediately; after the information from residents' committees about DV sent to the officers, community police officers would also contact with the related persons immediately".
Yue et al. (48)	2019	"The main character Mei Xiangnan is a school teacher who endured severe physical and psychological abuse by her husband An Jiahe, a well-respected surgeon. Mei silently tolerated the domestic abuse out of fear that she would be ostracized if she made public what was a private **family affair**. Instead of ebbing, the cycle of violence kept escalating".

DISCUSSION

This study set out to investigate key barriers to domestic violence research development in China, with a close focus on salient cultural influences. Our research is the first that explored barriers that hinder the public and policymakers' understanding of the full scale and scope of domestic violence in China. While many factors shape the lack of domestic violence research in China, we focused on salient cultural influences that are most discussed in published academic papers. The study findings show that, by diminishing domestic violence crimes into "private" "family affairs", cultural and social norms play a defining role in shaping the domestic violence narrative and public awareness of the topic in China (27). The results also indicate that almost all key stakeholders, ranging from abusers, witnesses, families and friends, victims, to police officers, often dismiss domestic violence crimes as matters of "family affairs" that reside outside the reach and realm of the law [e.g., (24, 28, 47)]. These sobering insights combined, in turn, shed light on why the current research development is insufficient to inform the public and policymakers about the full scale and scope of domestic violence in China.

Domestic Violence as a "Family Affair"

Our findings show that categorizing domestic violence as a "family affair" is a critical barrier to domestic violence research development in China—an incremental hindrance that prevents the public and policymakers from understanding the prevalence, severity, and repercussions of domestic violence in China. In light of the human and economic tolls associated with domestic violence, the public nature of domestic violence crimes, as indicated in its impacts on all sectors of societies, as opposed to limiting it as "private" and "family affairs", is abundantly evident (49–53). Analyses conducted in the United States in 2014, for instance, show that domestic violence lifetime cost was $103,767 per female victim and $23,414 for individual male victims, paired with the fact that 43 million U.S. adults are victims of domestic violence, the total cost of domestic violence on society could amount to $3.6 trillion over victims' lifetime (54). However, due to poor research development, it is unclear in terms of what might be the totality of the human and economic toll of domestic violence in China, let alone insights that factor in the most up-to-date impacts of COVID-19 on the scale, scope, and severity of domestic violence in the country.

What is clear, though, is China has nearly four times the U.S.'s population (55), and lacks the domestic violence prevention

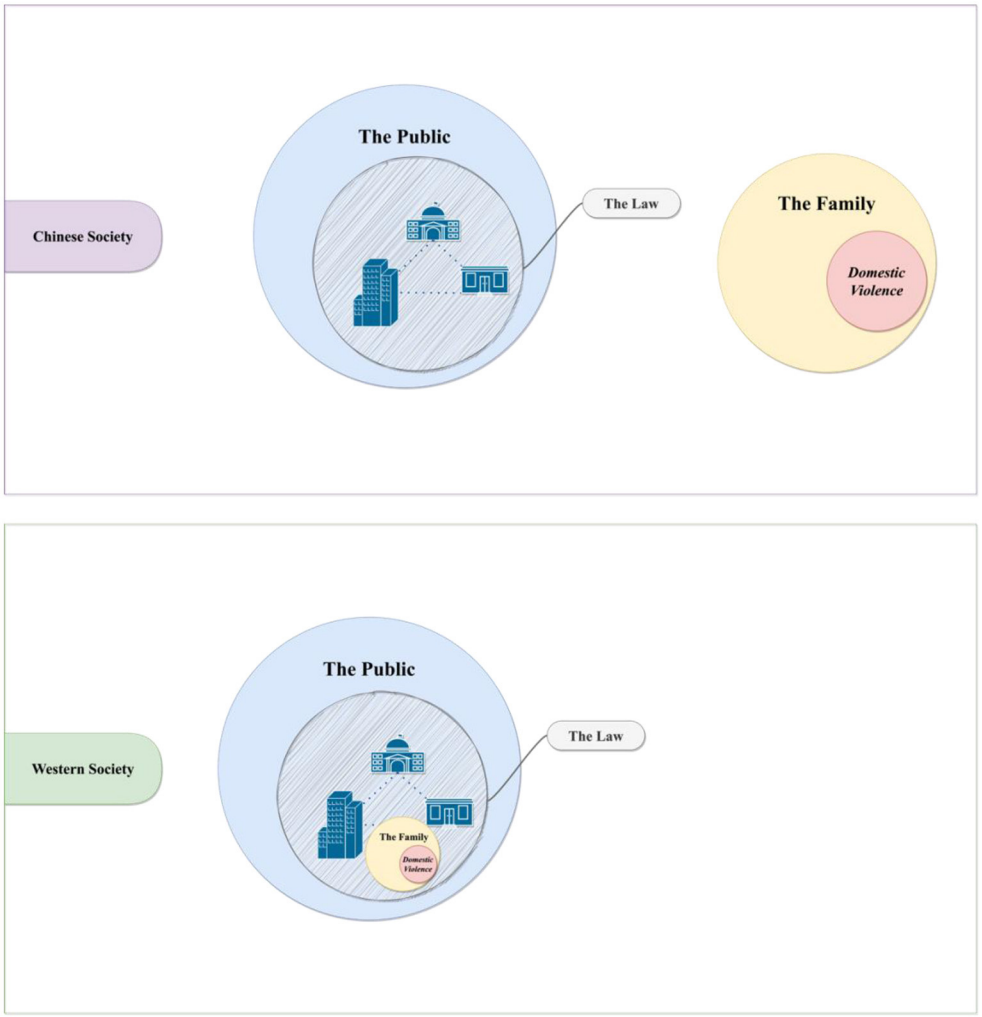

FIGURE 2 | A schematic representation of the unique categorization of domestic violence in China.

infrastructure that is available in developed countries such as the U.S. (56–58), critical intervention mechanisms that have the potential to help victims fend off the adverse impacts of domestic violence. These insights combined, in turn, further underscore the problematic nature of the research gap. Without essentials such as domestic violence crime reporting, monitoring, and surveillance, basic understanding such as what are the impacts of domestic violence on avoidable medical experiences, workforce productivity lost, and long-term social stability could not be achieved. Needless to say, without these understandings, government and health officials may not be able to evaluate, let alone prevent, the repercussions of domestic violence as an overlooked public health epidemic on the health and wellbeing of the society at large.

It is important to note that dismissing domestic violence crimes as matters of "family affairs" is not a phenomenon that is unique to China. Many societies, for instance, either due to population makeup or geographical proximity to China, also face the issue (59–63). Furthermore, cultures that are often influenced by traditional or conventional social beliefs, such as the Arab world, also found that "family affairs" could be a frequent excuse cited by abusers for their crimes and a salient barrier that prevents victims from seeking help (64–66). However, what is unique about categorizing domestic violence crimes as "family affairs" in China centers on its prevalence and pervasiveness. The study findings show that, in addition to abusers, witnesses, and victims, even law enforcement in China often dismisses domestic violence crimes as "family affairs" that reside outside the reach and realm of the law (40, 45, 67). A schematic representation of the unique categorization of domestic violence in Chinese society, as found in our analyses, could be seen in **Figure 2**.

In a study on accident and emergency nurses in Hong Kong, researchers found that 43% of the participants do not believe they have a duty to intervene in violence domestic cases (43). What is equally, if not more, alarming, is that in the same study, among all of the 57% of nurses who indicated they

should intervene, all of them endorsed the traditional Chinese saying— "even a good judge cannot adjudicate family disputes" (43). Similar patterns—failing to help domestic violence victims per their job descriptions and the requirement of the law—are also found in other stakeholders (47). These insights combined suggest that in order to fundamentally change this corrosive practice of labeling domestic violence crimes as "family affairs", systematical measures led by government and health officials are needed urgently.

A Social Ecological Approach

One way to effectively change the cultural influences and social norms associated with equating domestic violence as a "family affair" is via addressing the issue from a social ecological perspective (68). The social ecological model suggests that public behaviors are often shaped by various influences with different levels of social implications. These influences could often be grouped into the intrapersonal, interpersonal, organizational, community, and policy level factors (68). Drawing insights from the social ecological model, we propose a government-led, community-facilitated, organization-sponsored, and individual-responsible approach to address the deep-rooted cultural and social influences on domestic violence in China.

Change the "Family Affair" Narrative

It is important to underscore that, as evidenced in behavioral sciences literature (69–71), referencing domestic violence as a "family affair" could reduce the perceived severity and create a climate of complacency in society. To effectively address this issue, media professionals, health organizations, and perhaps most importantly, government agencies need to take a more significant role in changing the narrative surrounding domestic violence. Government agencies, for instance, especially those involved in or associated with law enforcement, need to set the example of banning the misleading use of "family affair" in formal and informal reference to domestic violence. Persuasive health campaign interventions could also help change the narrative. Health campaign interventions can be understood as using communication or marketing tools and techniques to change the target audience's attitudes and behavior toward a health phenomenon (72). As the literature suggests, health campaign interventions are effective in shifting culture and social norms around a social phenomenon (72–76). Considering that the association between domestic violence and "family affair" is deeply rooted in the Chinese culture, the government must initiate health campaign interventions tailored to social norms around the "family affair" phenomenon (77–79).

Improve Women's Financial Autonomy

It is important to note that the Chinese government has been making progress in improving women's rights. In a Lancet study on Chinese women's overall health and quality of life development, ample evidence shows that substantial strides were made in the past 70 years (80). However, ingrained issues may need the government's sustained intervention to address. For instance, though China's gender wage gap has been relatively low compared to countries such as the U.S. (81), it has been on the rise (82). Recurring evidence shows that financial capabilities are often closely linked to women's susceptibility to domestic violence (83). In other words, it is possible that financial autonomy has the potential to help women think and live above submissive culture patterns (84), such as cultural influences that translate domestic violence crimes into "family affairs". These insights combined suggest that addressing the gender wage gap in China could be a key strategy that the Chinese government could adopt to mitigate domestic violence.

Interventions That Hold Individuals Responsible

Another critical intervention that policymakers should consider is improving the utility and functionality of the 2016 Anti-Domestic Violence Law in China, implementation of which has been lax among law enforcement personnel (32, 85, 86). In addition to traditional intervention programs designed for abusers (e.g., training or rehabilitation opportunities) (87), another way to address this issue is via incorporating domestic violence abuser history for the past 5 years as a part of individuals'—both male and female job seekers—eligibility for applying for and working at the public sectors. In other words, people with a record of domestic violence crimes for the past 5 years should not be allowed to apply for working as public servants, vital personnel who might be exposed to tasks that are inappropriate for abusers, such as domestic violence victims relocation.

A key advantage of this program centers on its non-judgmental attitude toward whether domestic violence crimes are "family affairs". Essentially, the proposed intervention approach aims to address domestic violence at the behavioral level, as opposed to the belief level—regardless of which belief systems the abusers hold or how conventional their views toward family or women might be (88–90), if they commit domestic violence crimes for the past 5 years, they should not be allowed in desirable and high-stake jobs like pubic servants. Needless to say, due to its novelty—no such interventions have been previously deployed in China, rigorous and evidence-based development processes are needed to ensure this intervention has the potential to reach the desirable intervention outcome—reduce domestic violence prevalence in China in scale. In the same vein, the central government should also make abilities to implement the Anti-Domestic Violence Law a key capacity of the local governments. As a matter of fact, Changsha, the capital city of Hunan Province, China, has already made domestic violence prevention a key component of their performance assessment rubric—effectively making abilities to prevent domestic violence a part of public officials' job descriptions (91). Overall, the promises of these approaches center on their potential to incentivize both individuals and local governments to invest in domestic violence prevention efforts on a daily basis.

Community-Facilitated Collaborative Interventions

In addition to incentivizing current or formal domestic violence abusers to not commit domestic violence crimes via

potential career prospects and job opportunities, limiting these perpetrators' access to victims or opportunities to inflict harm may also be a practical approach. For instance, making domestic violence history searchable in the national marriage registry free of charge could help women avoid being exposed to these abusers. To further incentivize abusers to refrain from harming their current or formal intimate partners, making the records "dormant" if the perpetrators are able to manage to not commit domestic violence for 5 years could be another effective behavior nudge. Currently, Yiwu, a southern city in China, has already made such a searchable digital system available city-wide (92). Overall, this big data-based domestic violence surveillance and monitoring mechanism have the potential to engage all stakeholders, ranging from victims, families and friends, community members, city officials, health experts, to abusers, in curbing and controlling domestic violence crimes across sectors of societies.

Limitations

While our study bridges important research gaps, it is not without limitations. First, the narrative review approach was adopted to gauge the research question. While a narrative review could be a key step in determining the suitability of systematic reviews, the non-systematic nature of the research method nonetheless limits the study results' reproducibility and replicability (93). Furthermore, we only reviewed scholarly literature published in English. As our key research objective is to gauge the scale and scope of academic work available on domestic violence in China, this decision is well-justified. However, by doing this, it is possible that insights published in Chinese or other languages in non-academic venues are not presented in this study. To address these issues, future research could adopt the systematic review approach to examine the research question with a search that is both broad and comprehensive.

CONCLUSION

Domestic violence endangers public health and social stability. Our study found that dismissing domestic violence crimes as "family affairs" is a key reason why China's domestic violence research is scarce and awareness is low. In light of the government's voiced support for women's rights, we call for the Chinese government to develop effective interventions to timely and effectively address the domestic violence epidemic in China. To further shed light on the issue, future research could develop interventions that target the corrosive practice of treating domestic violence in China as a "family affair" to further improve women's health and quality of life, public health and wellbeing, social stability, as well as global solidarity.

AUTHOR CONTRIBUTIONS

ZS developed the research idea and drafted the manuscript. DM, AC, JA, HC, SŠ, and YC reviewed and revised the manuscript. All authors contributed to the article and approved the submitted version.

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Health Policy Development During COVID-19 in Saudi Arabia: Mixed Methods Analysis

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Healthcare systems are increasingly required to utilize effective approaches, apply evidence-based practice, and consequently sustain successful strategic management. Document analysis provides insights into the effective management tools applied by agencies to respond to crises. This article provides a practical exploration of how the Saudi health authority applied effective measures to eventually reduce the administrative and clinical consequences while managing the COVID-19 pandemic. The conceptual descriptive framework was based on health policy triangle of Walt and Gilson. Official reports and supporting documents issued by the Saudi government toward COVID-19 were operationally analyzed. Moreover, five healthcare professional experts were invited in a semistructured interview to assess the strategic steps that have been utilized to minimize the health risk by conducting a healthcare risk analysis. Various documents showed that two major entities were responsible for managing regulations and medications of COVID-19 in addition to six other entities that were partially involved. Although each entity was approved to work independently, their efforts were cohesively associated with each other. Most documents were well-applied on personal, social, organizational, and national strata. However, it is unclear how lessons identified became affirmative, while the collaboration remains vague, especially under the emergence of a new entity such as the Public Health Authority. Healthcare professional experts also positively supported the effectiveness of such policies to confront COVID-19 through the following three domains: health guidelines, utilizing simulation (telehealth/telecommunication) services, and ensuring continuity of services.

Keywords: health management, COVID-19, document analysis, public health, authority

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INTRODUCTION

Late 2019, an infectious disease is known as corona virus disease (COVID-19) has speared widely all over the world causing devastating impact not only on global health but also on the world economy that reached its lowest levels. The first cases of pneumonia of unknown cause were detected in Wuhan, China. This has impacted China and countries of the world causing a global outbreak. Each country, as a result, initiated some effective measures to reduce the consequences of such a pandemic locally, or with the support of the World Health Organization (WHO) (1).

The kingdom of Saudi Arabia (KSA) has encountered various challenges during this pandemic but was able to set some measures to reduce the impact to the minimum. Protective measures include building COVID-19 healthcare centers, providing free treatment and healthcare to all, specifying fever clinics in all cities, public and private hospitals, and were designed only to receive patients with COVID-19 symptoms (2, 3). Yet, around 60,000 cases were reported in the early 6 months of the crisis, and the nation lost almost 8,000 lives by June 2021. Saudi Arabia, among many other international healthcare systems, has responded immediately to the pandemic by introducing various health and safety measures and precaution protocols, however, some of those systems often struggled to reduce the mortality and morbidity of COVID-19 among their population (4). Generally speaking, multiple factors are associated with the success in improving healthcare outcomes of healthcare policies, content, context, and processes (5). Moreover, KSA was among the early countries to mitigate the impact of COVID-19 even before the first case was reported. This was achieved by implementing early precautionary measures learned from past outbreaks, such as, the Middle East respiratory syndrome (MERS) and the severe acute respiratory syndrome (SARS) which are both classed as corona viruses. From early January 2020, such measures included the formation of a national committee to prepare for the possible introduction and spread of the virus and to follow up with global updates of the outbreak. Proactive decisions were announced by the committee that consisted of collaborated ministries like the ministry of health, education, interior, and more. Decisions included banning all flights from China, suspending entry to tourists and to those who were to visit the holy cities of Makkah and Madinah, and shifting education of all levels to online and virtual teaching (6). Hence, it would be academically and professionally valuable to assess the management of COVID-19 in the Saudi healthcare system during this pandemic.

Defining COVID-19 Confirmed Cases

While there are three types of COVID-19 case definitions, namely, suspected cases, probable cases, and confirmed cases, ultimately, there are two major steps toward confirming cases and this may include:

1. Individuals who have symptoms and meet specific clinical criteria, like healthcare professionals, suspected individuals, and new-comers from overseas.
2. Results of testing of positive COVID-19 symptoms, through suspected or referral cases.

Healthcare Policy Analysis Model

Within the wide variety of models and theories, selecting the appropriate approach to analyze healthcare policies needs to clearly explain the domains that contribute insightfully to reducing the consequences of the phenomena. This model, for example, should be based on the research objectives and the availability of data within a particular context (7). However, analyzing the Saudi healthcare policy requires a comprehensive exploration of various factors and elements (8). The most widely, reliable, and valid framework to apply, in our case, is perhaps Walt and Gilson's healthcare policy triangle (9). This framework is particularly helpful in explaining the macro level of the healthcare policy and any other related politics (10). Simply, this triangular framework consists of: content, context, and process investigates through direct influencers to shape policy-making.

Walt and Gilson's triangular framework for healthcare policy is considered a useful tool to analyze healthcare policy systems due to their robustness and consistency (11). Contextual factors such as political, economic, and sociocultural influence the healthcare policy management of COVID-19, this is explained through a well-constructed control policy process of implementing, monitoring, and evaluation. Indeed, this model allows for a more objective analysis of previous healthcare policies, and it indicates a clear framework of how policy-making can make integration through actors, process, context, and content. Actors are defined as key players in formulating the influence on healthcare policy (12).

During COVID-19, those protocols were the most influential factors that significantly contributed to formulate the current medical guidelines. The process is a series of actions taken to document the experience of specific actions in a healthcare system from a research prototype into action in that system. Experimental results from the healthcare field environments are daily obtainable. While context is normally associated with facilities or barriers that may move or hinder healthcare outcomes, they may indicate failure or success on some occasions. Content is associated with variance, but tackling sources with heterogeneous grounded.

To simplify, the model includes the content, the context, and the process of policy reform conducted by the actors. Despite the interaction of each element with one another, the model will be clear through visualizing the risks enforced by many parties.

Risk-Adjusted Model

Maintaining services during normal activities is a critical step to the health risk adjustment, and this may include continuous monitoring to the delivery of safe and effective healthcare services (13). It is a reflection of how the system can survive to provide the basic and advanced medical services based on healthcare leadership responses to the crisis through effective measures. Statistics and health economics are tools widely used to measure adjusted risks. For example, daily reports of patients through monitoring structure, processes, and outcome activities are common to reduce health risks. This is normally associated with economic variables like cost-benefit analysis. Healthcare systems in KSA are diverse, however, the Ministry of Health (MOH) is considered the main healthcare provider that overlooks, regulates, and manages all the different healthcare systems in the country.

The COVID-19 pandemic has a major impact on healthcare systems across the globe and Saudi Arabia is not an exception. Saudi Arabia was one of the leading countries that initiated effective measures to reduce such risks. Those micro and macro levels were based on a series of applications and decisive measures of prevention, control, and specific treatments that were not fully documented in the literature (3, 14). The need to address changes in policies, personnel, and administrative

preventive measures are key issues in public health and health risk adjustment. Indeed, rules and regulations were quickly stated and updated through a new design of the healthcare system delivery, representing interrelated groups (15).

Indeed, healthcare policies legislated by politicians, economists, and healthcare administrators interfere in collaboration to reduce the devastating impact of COVID-19 on the healthcare systems. The aim of this study is to analyze healthcare policies, on both the macro and micro levels in relevance to COVID-19 management in KSA using Walt and Gilson's policy triangular model (16).

METHODS

Design

Qualitative and quantitative analysis design was used primarily to explore the initiatives proposed by the Saudi healthcare agencies to reduce the risk of COVID-19. The main research question is how the healthcare policy was influenced by certain factors while confronting the COVID-19 crisis. More than 106 official initiatives were analyzed. Incorporating policies, procedures, protocols, and guidelines, gray areas were combined with their associated main reference if there was any.

Expert healthcare professions represented in the sample were selected due to their healthcare performance that was linked to the pandemic outbreak. To explore themes, different techniques were used, for instance, word analysis and assimilating of texts and contexts.

Procedure

In this analysis, this study explores the Saudi Arabian healthcare system in managing COVID-19 on macro and micro levels, supported by identified examples of relevant policy documents and interviews of the COVID-19 expert healthcare professional. Selected documents provided information about prevention, crisis control, and documents that were assessing the political, economical, social, and historical context of COVID-19 management in KSA. This study is a critical review based on various primary and secondary data collected from expertise, government references, reports, and articles.

The validity of the data was based on data credibility, transferability, dependability, and confirmability. Applying triangulation, through coding, analysis, and interpretation of official documents, was appropriately sufficient. Moreover, applying contextualization within multimeaningful channels assured inclusive data. Finally, data should be perpetually relevant to COVID-19 management policy with a significant influence on the population (17).

Data Extraction and Synthesis

The primary aim of the document analysis was to categorize the contents, processes, and context of potential themes. Data search began with an examination of the clear-cut literature (government documents, official websites, and mass media websites). The published policy documents were indexed and listed based on a thematic paradigm. Each document was attributed to its main source, i.e., who issued it? Indeed, a neutral stance to obtain the data was applied to prevent bias. Initially, data were coded under multiple levels based on the level of influence allowing them to be recorded based on Walt and Gilson's policy triangular model.

Again, data were reclassified according to the study framework where the actors played three essential roles: content; context, and process. To do this, data were extracted in a template sheet based on the study framework. The study was limited to national healthcare initiatives by government policies and plans to minimize the risks of COVID-19.

Data Collection

A semistructured interview was conducted independently and remotely via a teleconferencing software (Zoom) with five expert healthcare professionals to assess the following:

1. Was the Saudi healthcare system successful in managing the COVID-19 crisis? How and why?
2. Which entity/public organization was available 24/7 to reduce available risks? How?
3. To what extent do you believe that such a strategy has reduced available risks? Explain.
4. What are the major areas that the Saudi healthcare system targeted to reduce available risks? Give examples.
5. Which entity can continue more to support rules and regulations to manage the pandemic? How?

In addition, ten close-ended questions were asked to all five participants by an independent researcher from the Saudi Society of Health Administration. Participants had no previous contact with the interviewer. The interviewer followed specific interview guidelines that focused on the experiences and management of the participants during the COVID-19 pandemic. Direct and indirect inquiries were used to encourage participants to focus on certain aspects that needed to be explored in more analysis.

Interviews took place remotely during January and March of 2021 in Riyadh Region via teleconferencing software. All interviews were run in standard English, as participants were Western-country graduates with high proficiency in English. Each interview was around 30–45 min long. Experts were selected (purposeful sampling) based on their direct involvement in managing the crisis, first of all. This involved identifying and selecting subjects who are especially knowledgeable about COVID-19 and implementing its strategies in KSA.

Data Analysis

In this stage, both themes and patterns were identified upon completing the research protocol transcription. Researchers then coded the data by ordering the basic theme code, then sketching the pattern coding.

Indeed, the sequential phases offered strata of triangulation based on the applied research model. Each step ensured alignment with the model, data accuracy, and replicability. The purpose of this step was to construct analysis rather than syntax analysis. All steps were based on deductive coding.

Utilizing quantitative data to measure various parameters was a helpful tool to explore more the initiatives proposed by gathered official documents. Thus, data gathered from

national or international resources could be established across a population to infer a conclusion.

RESULTS

In an attempt to increase the number of documents and to ensure reliability, the researchers expanded the scope of the search for in-depth information from other official resources, as selected organizations are official national entities where daily surveillance of the pandemic is reported continuously. Essential guidelines and system implementations were found among eight institutions that confront COVID-19. Official resources included reports, guidelines, roles, and regulations, driven from the Ministry of Health (MOH), Ministry of Interior (MOI), Ministry of Education (MOE), Ministry of Human Resources (MOHR), Ministry of Finance (MOF), Ministry of Hajj and Umrah, Ministry of Information and Technology (MOIT), and finally the Ministry of Media (MOM).

Major and supportive entities involved in the formulation of the healthcare policy and engagement were also examined. **Table 1** includes a summary of the volume of examined documents.

As government reports were identified on two levels, only abstract judgments were reported. If no direct impact was observed; then the level of influence is secondary. After that, applying the deductive approach, the framework synthesis, then identifying and summarizing imperative data drawn from the document. First, each document was analyzed to express four levels: national, organizational, social, and personal. Such aim can thoroughly assess to what extent the elements of framework of the Walt and Gilson were reflected. Second, in a deductive approach, new themes were developed and included as they emerged from the data.

Simply, actors refer to key players who significantly contribute to developing, applying, managing, and accessing COVID-19 healthcare policies. This may include a wide range of organizations involved in significant activities that are likely to directly influence COVID-19 management.

On the micro level, the Saudi MOH is responsible for developing policies in which implementation programs support the system that is in alignment with regulations. As the MOH provides clinical services, the need to strictly support the administrative side is clear when there is a need to apply mandatory actions like lockdown, social distancing, and mask wearing.

Table 2 shows the sociodemographic characteristics of the expert healthcare professionals who participated in the study.

Table 3 describes basic inquiries of the process combat of the Saudi healthcare system toward COVID19 management from the point of view of participants.

Experts who were interviewed as participants, also positively supported the effectiveness of introduced policies to confront COVID-19 through three domains: health guidelines, utilizing simulation (telehealth/telecommunication) services, and ensuring continuity of services. The following will discuss each theme individually.

Health Guidelines

Health guidelines refer to both documentation and implementation of procedures to reduce risks among the population. Health guidelines emerged as a prominent theme from the semistructured interview data. The analysis indicated the perceptions of the expert healthcare professionals and understanding of the well-supported medical and non-medical guidelines. The essential step toward guidelines was patient access to healthcare services regardless of gender, ethnicity, and nationality. Immigrants and illegal residents were also allowed

TABLE 2 | Basic demographic characteristics of the experts ($n = 5$).

Characteristics	*n*	%
Gender		
Male	3	60
Female	2	40
Education		
Ph.D., or equivalent	2	40
Masters' degree	2	40
Bachelor degree	1	20
Position		
CEO	3	60
MD	1	20
Other	1	20
Experience	Min = 10	Max = 25

CEO, chief executive office; MD, medical doctor.

TABLE 1 | List of public policy elements identified based on their influence.

Level of policy engagement	Major entity		Supportive entity					
	MOH	MOI	MOE	MOHR	MOF	MOHU	MOI and T	MOM
National	6***	6***	2*	5**	3*	4*	3*	3*
Organizational	6***	5**	3*	3*	2*	4*	2*	4*
Social	5**	5**	4*	2*	1*	2*	1*	4*
Personal	4*	6***	5**	1*	1*	1*	1*	2*

****High influence; **Intermediate influence; *Low influence (the number indicates the volume of distribution documents as a parameter).*

TABLE 3 | Close-ended interview questions result of selected expert healthcare professionals ($n = 5$).

Question	Yes		Not sure		No	
	n	%	*n*	%	*n*	%
Was the system effective?	5	100	0	0	0	0
Were all public institutions independent?	5	100	0	0	0	0
Was the system well integrated?	3	60	2	40	0	0
Was the risk reduced?	5	100	0	0	0	0
Was health leadership competent?	4	80	1	20	0	0
Were resources available?	3	60	1	20	1	20
Were national communications effective during the crisis?	3	60	1	20	1	20
Was there a national contingency plan?	4	80	1	20	0	0
Was there an organizational contingency plan?	2	40	1	20	2	40
Do you have an established risk modeling culture?	1	20	1	20	3	60

to be treated in public hospitals without any financial liabilities. Accessibility of records and information to track vulnerable cases were available to healthcare policymakers.

> "I wouldn't be able to appreciate the ability of the public services, especially Public Health Authority, to confront COVID-19 till I received health guidelines to what to do, when, how, and why. Nothing better than guidelines that could confront the crisis." (Expert healthcare professional 2)

Seniors, people with chronic disease, and healthcare staff had direct and quick access to healthcare services (18). All health professionals were strictly warned to apply all COVID-19 management protocols. Any violations will be assessed and may lead to penalties and law breaching.

> "What the public policy added to healthcare system was medical guidelines including patient safety and high quality of care. Imagine we control COVID-19, but in unsafe environment? All our health plans will be invalid." (Expert healthcare professional 5)

Thus, a subset of participants across all disciplines appreciated the advanced guidelines with its integrated system to reduce risks (19).

Utilizing Simulation Services (Telehealth/Telecommunication)

The ability to solve real-world problems in a safe, efficient, and effective way is an essential element to utilize services. For instance, during the partial lockdown, many patients were unable to move freely to be examined by a physician. Virtual clinics were essential parts not only within remote areas but also in cosmopolitan cities.

> "We are now launching a virtual hospital to be part of the services provided to the population. MOH will not stop improving the performance of healthcare services. All hospital facilities, including lab tests and x-rays will be monitored and operated in very innovate ways." (Expert healthcare professional 1)

TABLE 4 | Expert healthcare professionals theme summary of the semistructured interviews of strategic initiatives toward COVID-19 management.

Domain	Subcategory examples
Health guidelines	Patient safety- access to healthcare
Simulations adaptation	Virtual clinics- technology-education-application
Continuity of services	Response and mitigation- reporting protocols-effective communications

> "Can you imagine that we are now using more than (20) health applications to reduce time and efforts for health providers and patients? The technology used is not reliable only but secure and other phases will be utilized to launch a virtual healthcare system." (Expert healthcare professional 2)
>
> "Online learning and education increased retention of information, changed dramatically, during COVID-19, with the distinctive rise of e-learning, whereby knowledge-transfer has become the value of education." (Expert healthcare professional 5)

With this strategic shift, the Saudi healthcare system adopted simulations (telecommunication methods) in education, particularly in health schools, and continue to do so post-pandemic. Moreover, new paradigms evolved to impact not only providers of the healthcare services but also end-users of the system (21).

Ensuring Continuity of Services

This sets out how healthcare organizations prepare for a pandemic and continue to operate after it. Indeed, this will lead to reduce recovery time and enhance service continuity. A recovery plan is essential to ensure successful healthcare services delivery and management (22).

> "The Saudi government, especially Public Health Authority, plans of mitigation of activities were essential to prevent more spread of the disease, reduce the chance of a risk happening, and reduce undesired effects. National administrative and health steps applied before and after COVID-19." (Expert healthcare professional 3)

"Well, Key performance indicators are now well-known during COVID-19 report hourly cases in MOH dashboard. The phenomenology of spread infection is tracked through specific protocols applied by higher authority." (Expert healthcare professional 2)

"Only official agencies like MOH and MOI were the main resource to keep the channel between the population through daily accurate conference as early as possible. This approved that information is transferred in more effective and reliable way: it is a psychological impact where rumors are void." (Expert healthcare professional 5)

The conclusion of the semistructured interviews indicated the effective application of healthcare measures in the pre-pandemic, during a pandemic, and post-pandemic times. **Table 4** shows the conclusion of the semistructured interviews among the five expert healthcare professionals in the healthcare system.

The relationship between different facilities at different levels was not well-organized, and there was a lack of clear channels of communication or policies for sending patients from one specialized hospital to a primary healthcare or a public hospital (23). Conversely, the privatization of healthcare services was frozen to confront the crisis. The number of individuals who were fully or partially vaccinated up till July 2021 is stated in **Figure 1**.

However, compared to other countries, fully vaccinated individuals in KSA reached almost 25% of the population by the second half of 2021. COVID-19 control measures were developed by the higher authority in KSA including MOH and MOI to primarily alleviate pain from the population regardless of ethnicity, gender, and nationality. The subgoals of this plan were to control and prevent COVID-19 from getting more complicated and out of control.

DISCUSSION

This research explored key different materials collected from various official resources to trace the macro and micro measurements applied by public organizations in KSA during COVID-19 management. In addition, this research study invited expert healthcare professionals who could contribute to illustrating the risk-reduction on the micro levels. Basically, a policy triangular framework is rooted in a transitional period of both politics and economics. Overall, elements like actors, content, context, and process were represented in this study by healthcare entities, crisis management of COVID-19, and the public healthcare performance, respectively (12). Indeed, this framework has influenced the healthcare policy to outperform and innovate more than what the healthcare system used to Gilson and Raphaely (24). Moreover, KSA was among the early countries to mitigate the impact of COVID-19 even before the first case was reported. This was achieved by the implementation of early precautionary measures learned from past outbreaks, such as, the MERS and the SARS which are both corona viruses.

In Saudi Arabia, public policy strategy toward the management of COVID-19 has approved its effectiveness to prevent the spread of such a disease within its scope through diverse sectors (4). On a micro level, for example, two major organizations were responsible directly for the clinical and administrative roles within this unprecedented pandemic, confronting a paradox in interrelated authorities (15, 25). The mission of each entity was to seek overall high performance and authority. This activity is relatively higher than the normal procedure to confront sudden national hazards. Also, previous studies from other countries reported security enforcement rather than clinical involvement. For example, healthcare system effectiveness and independence were the most prominent characteristics associated with the Saudi healthcare system, and this is a major requirement according to many international standards including the Institute of Medicine recommendations (3, 26).

There are some possible explanations for the control of only two entities in this crisis. First, the Saudi healthcare system

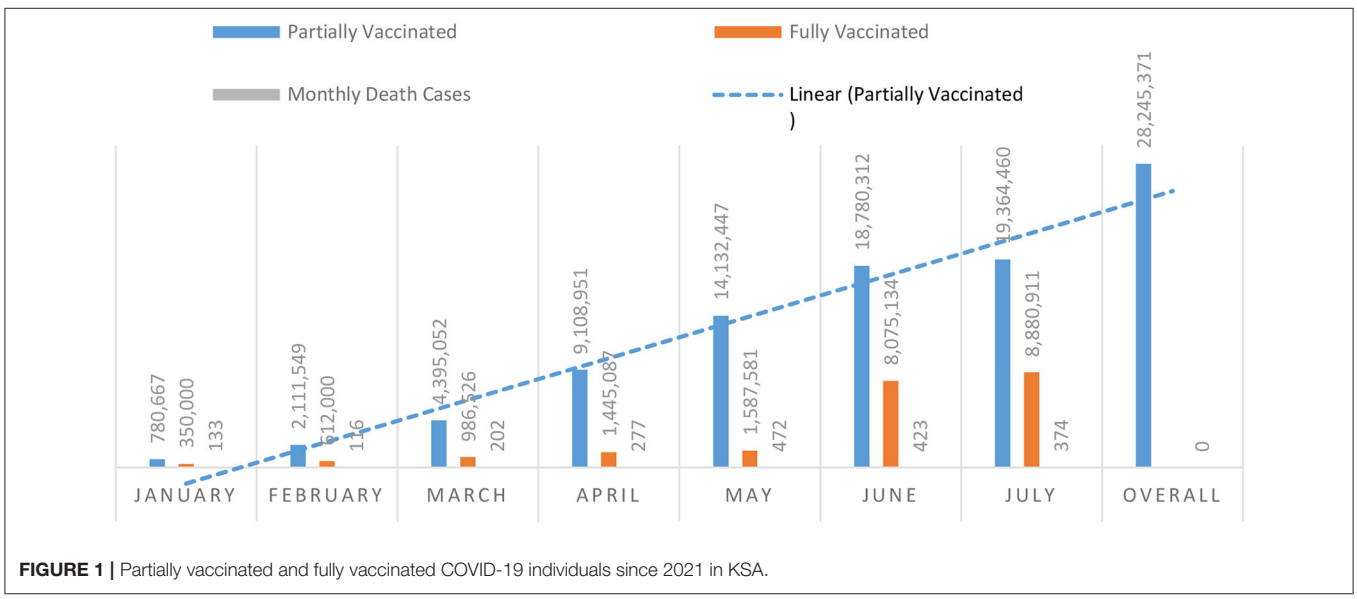

FIGURE 1 | Partially vaccinated and fully vaccinated COVID-19 individuals since 2021 in KSA.

is well-established politically where irrelevant entities cannot penetrate the rules and regulations easily (27). Perhaps most of the democratic states faced reluctant measure enforcements to confront such a crisis (28). Second, the organizational culture is based on the public socialization process where Saudi people acquire their beliefs, values, and attitudes of the culture in which they find themselves independently. Assumingly, such behaviors have been adopted through experience within specific social and cultural nature (3). Moreover, transparency of applying extensive measures increased confidence of the people in healthcare leadership as there was a linear indication in the world report (29).

The decrease in the number of death cases with a decrease in overall cases might be associated with the recent policy implemented by the government. Medical guidelines definitely strengthen hospital capabilities to tackle concurrent and future health challenges. Indeed, effective disease surveillance and response are key performance indicators to maintain a strong healthcare system, especially through leadership and a political system (19). Although KSA has imposed lockdown and other strict measures, simulation (telecommunication/telehealth) was used widely to deliver effective education, wide information, and predict the progress of the outbreak and its possible end (21). In addition, the pandemic generated challenging opportunities for creating a new value: continuity of services. Healthcare service continuity has preserved the value of health although risks were surrounded, by applying public-private partnerships and financial stimulation (30). The conclusion indicated that the government, especially the public health authority, is still committed to providing updated regulations, technical support, and sustainable services for the population through multisectoral collaboration and coordination mechanisms among various entities (20).

While avoiding potential financial consequences, needs of patients were the center of the Saudi healthcare system. As indicated earlier, the medical services are provided free of charge and all individuals (citizens, non-citizens, and illegal residents) were exempted from any financial requirements related to COVID-19 (8). Although illegal residents represent a small portion of the country, yet they add an extra burden on the whole healthcare system. Consequently, this was a stimulus to avoid infections and increase early detection of COVID-19 cases. Thus, the inability to withstand the effects of a hostile environment was eliminated, and people were confident that they will be equally treated, and they would be covered from potential risks and would be able to access healthcare services without spreading the disease among others (31). In simple, risks posed to patient safety were mitigated using patient-specific risk management strategies such as free-public health services, non-financial liabilities, and meeting the expectations and needs of patients.

Limitations of this study include the short period of conducting the cross-sectional study. In addition, there was a probability of bias toward having only one non-Saudi expert healthcare professional. In the absence of an agreed-on definition of what successful crisis management is, no clear assessment application was traced to determine the success of COVID-19 crisis management globally. One common successful method in the healthcare system is to reduce mortality and morbidity rates. However, the current research was designed to reduce ambiguity and to tailor the uniqueness of crisis management to be a good practice.

CONCLUSIONS

In this study, we applied mixed methods to gain insights into the methods applied by the Saudi healthcare agencies adopted to minimize risks and ensure continuity of healthcare services within the Saudi 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 studies involving human participants were reviewed and approved by Health Administration. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

All the authors substantially contributed to the conception, drafting, and approving this manuscript.

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Inclusivity of Persons With Disabilities in the Work Sector During the Covid-19 Pandemic in Indonesia

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Introduction: The COVID-19 pandemic has had a significant impact on all levels of society, including people with disabilities, who in the pre-pandemic period faced obstacles in various sectors of life that affected efforts to fulfill basic living needs due to difficulties in accessing employment.

Objective: The objective of this study was to identify various factors and causal interaction patterns that affect the inclusiveness of workers with disabilities in pandemic situations, a dynamic system is needed to capture causal interaction patterns related to the inclusiveness of workers with disabilities in pandemic situations.

Method: This study used a causal loop diagram approach, which is part of a dynamic system that begins with determining the interaction of causal variables. The process of identifying and extracting data was carried out through a literature review and in-depth interviews with informants who met the principles of appropriateness and adequacy criteria.

Result: The interaction pattern between the factors that influence the inclusiveness of disabled workers was depicted in three causal loop diagrams covering three major domains, namely social, educational, and economic aspects. The three causal loop diagrams showed an increasingly dynamic interaction pattern during the COVID-19 pandemic, considering that workers with disabilities have greater vulnerability, which impacts their level of acceptance and inclusiveness at work.

Recommendation: There needs to be a specific policy to expand the acceptance of workers with disabilities by strengthening cross-sectoral collaboration and company commitments. The existence of a policy that prioritizes education, increases the budget, and procures adequate infrastructure for people with disabilities is a government commitment that is demanded to be fulfilled during the COVID-19 pandemic.

Keywords: disability, inclusivity, workers, pandemic, Indonesia

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INTRODUCTION

A disability is defined as a condition or function judged to be significantly impaired relative to the usual standard of an individual or group. The term refers to individual functioning, including physical impairment, sensory impairment, cognitive impairment, intellectual impairment, mental illness, and various types of chronic disease (1). People with disabilities (PwDs) are people who

experience physical, intellectual, mental, and/or sensory limitations in the long term and who, when interacting with the environment, experience obstacles and difficulties in participating fully and effectively with other citizens based on equal rights (2). The inability and limitations experienced by PwDs often become obstacles to carrying out their daily activities, including getting a job. The stigma and community paradigms on PwDs often compare them to individuals who are unable to do anything and only need medical help, so they do not need education and work (3). This does not follow the regulations in the law, which state that every Indonesian citizen has the right to a worthy job (4). In addition to education, comfort, and welfare, work is essential for people with disabilities (5). Therefore, providing employment opportunities for PwDs is a challenge that needs to be considered by both the government and the community.

Prior to 1997, Indonesia issued regulations relating to PwDs, which stated that every person with a disability had equal access to work. Article 15 required that companies, both public and private, provide equal opportunities and treatment for PwDs by providing jobs according to the type and degree of disability, seen from the ability, education, and the amount that is adjusted to the company's qualifications (6). The regulation also stated that companies must employ at least one person with a disability who meets the requirements and qualifications for every 100 other employees. However, the reality is that few companies employ PwDs meet this minimum requirement (7–11).

In 2016, the Government of the Republic of Indonesia issued a new regulation regarding the number of disabled workers in a company, namely that government, regional, and state-owned companies employ a minimum of 2% of all employees with disabilities. Private companies are required to employ a minimum of 1% of the total number of employees (12). Based on data from Indonesian Statistics (BPS), the survey results show that the estimated number of PwDs in the labor market is 12.15%, with the medium category 10.29% and the severe category 1.87% based on the degree/severity of disability (13). In 2017, the Minister of Manpower stated that out of 440 companies with 237,000 employees, only 2,851, or around 1.2% of PwDs, were absorbed in the formal employment sector (14). Compared to the 2017 data, the number of disabled workers increased by 4,537 people in 2018 (15). In addition, companies that provide transportation facilities for workers with disabilities are still limited; five companies (7.04%) provide this service, while the remaining 66 companies (92.06%) do not provide transportation facilities for workers with disabilities (16).

The Covid-19 pandemic had a significant impact on all levels of society, including PwDs. PwDs also experienced obstacles in access, had difficulty meeting basic living needs, and were more vulnerable to Covid-19. There are several reasons PwDs are more at risk of contracting Covid-19, including barriers to implementing basic hygiene measures, difficulty in maintaining social distancing, depending on assistance in the form of touch from others (e.g., blind people), and limited information (17). For this reason, PwDs had to pay attention to their living conditions, as they were affected by the pandemic (18). The government needs to increase its support and attention to PwDs. Unfortunately, social services and rehabilitation of persons with disabilities program through the Ministry of Social Affairs is still limited, with only 19% of the budget available in 2010 (19).

The standard of living of PwDs needs to be increased through various government programs, not only related to the provision of regulations to increase the opportunities and competencies of PwDs at work, but also by increasing and expanding the education of PwDs. In this pandemic period, where online education is an alternative but with the limitations of PwDs, the support of the government, schools, communities, and families is needed (18). Unfortunately, government programs in the education sector also experienced delays during the pandemic.

This study aimed to identify various factors and patterns of interaction that affected the acceptance or inclusiveness of workers with disabilities during the Covid-19 pandemic using a dynamic systems approach.

MATERIALS AND METHODS

This study used a causal loop diagram approach, which is part of a dynamic system that begins by determining the interaction of causal variables. System dynamics involve mapping the system's behavior with the help of causal loop diagrams to understand the interdependencies between the parts of the system (20). Causal loop diagrams are a visual method that system thinkers use to explain feedback. The diagram is a language for articulating our understanding of the dynamic nature of the system being studied (21). The arrows indicate the direction of causality between cause and effect. The "+" symbol indicates unidirectional causality, and the "−" symbol in the arrow represents the opposite direction of causality.

Data were identified and extracted through a literature review and in-depth interviews. The research stage began with a literature review, which is the basis for researchers to identify factors and interaction patterns to build the initial causal loop design. Next, expert judgement was carried out to explore the literature review and sharpen the compiled causal loop diagrams. Expert judgment is the next stage in confirming the causal loop diagram and is performed by inviting an expert who has an educational and research background in the field of disabilities by in-depth interview.

Exploration Strategy

The literature sources for this narrative review were obtained from the Pubmed and Wiley Online Library databases. The author conducted a PRISMA Protocol Search to select articles based on title, abstract, and full articles and to determine their suitability to the research topic. The search used a combination of the keywords "employee," "disability," "inclusivity," and "pandemic."

Article Criteria

The inclusion criteria for this study were (1) written in English, (2) articles published from January 1, 2020 to September 7, 2021, (3) open access, (4) full-text articles, (5) all types of articles, and (6) contained keywords. The exclusion criteria were: (1) written in a language other than English, (2) article publications

conducted before 2020, (3) not freely available, (4) incomplete article text, and (5) no keywords.

Study Selection

Articles were selected based on the inclusion and exclusion criteria. Relevant and complete articles were included. The author chose articles based on the abstract and title of the article independently and was not bound by any party. The author made comparisons and decided on the similarities and differences between the selected articles. If there were any doubts about the abstract of an article, then the full text of the article was reviewed. A mutual agreement was made after each article was discussed.

Figure 1 shows the process of excluding research articles. The author obtained three articles from Pubmed and 82 articles from the Wiley Online Library. The authors had six articles remaining for eligibility selection, and all articles were selected for full article review because they fit the predetermined inclusion and exclusion criteria.

RESULTS

Based on the literature review results (see **Table 1**), the factors that influence the acceptance of disabled workers are socialization, cooperation, companies, PwD workers, PwD income, motivation, PwD unemployment, PwD careers, poverty, number of PwD students, education level, and PwD unemployment.

In-depth interview was conducted with resource people who are active in the health research center of one of the universities in Indonesia and who are observers of PwDs. Interviewees argued that the factors that influence the inclusiveness of PwDs in work include the following:

Positive factors that can contribute to the acceptance of PwDs.

1. High enthusiasm for work;
2. Increased awareness and understanding of human rights;
3. Zoning at each level for PwDs;
4. Indonesia already has a policy on disability;
5. Assistive technology to access various teachings;
6. The government provides rewards and awards to companies that employ PwDs and have excellent social responsibility.

Negative factors that can still be constraining:

1. Interest in achieving higher education is still low;
2. Access to information is not widely circulated in the general public;
3. PwDs feel reluctant and afraid of not being able to adapt;
4. Society needs to broaden education;
5. Pandemic;
6. The implementation and perspective of the community toward disability is still in the paradigm that PwDs are not productive people;

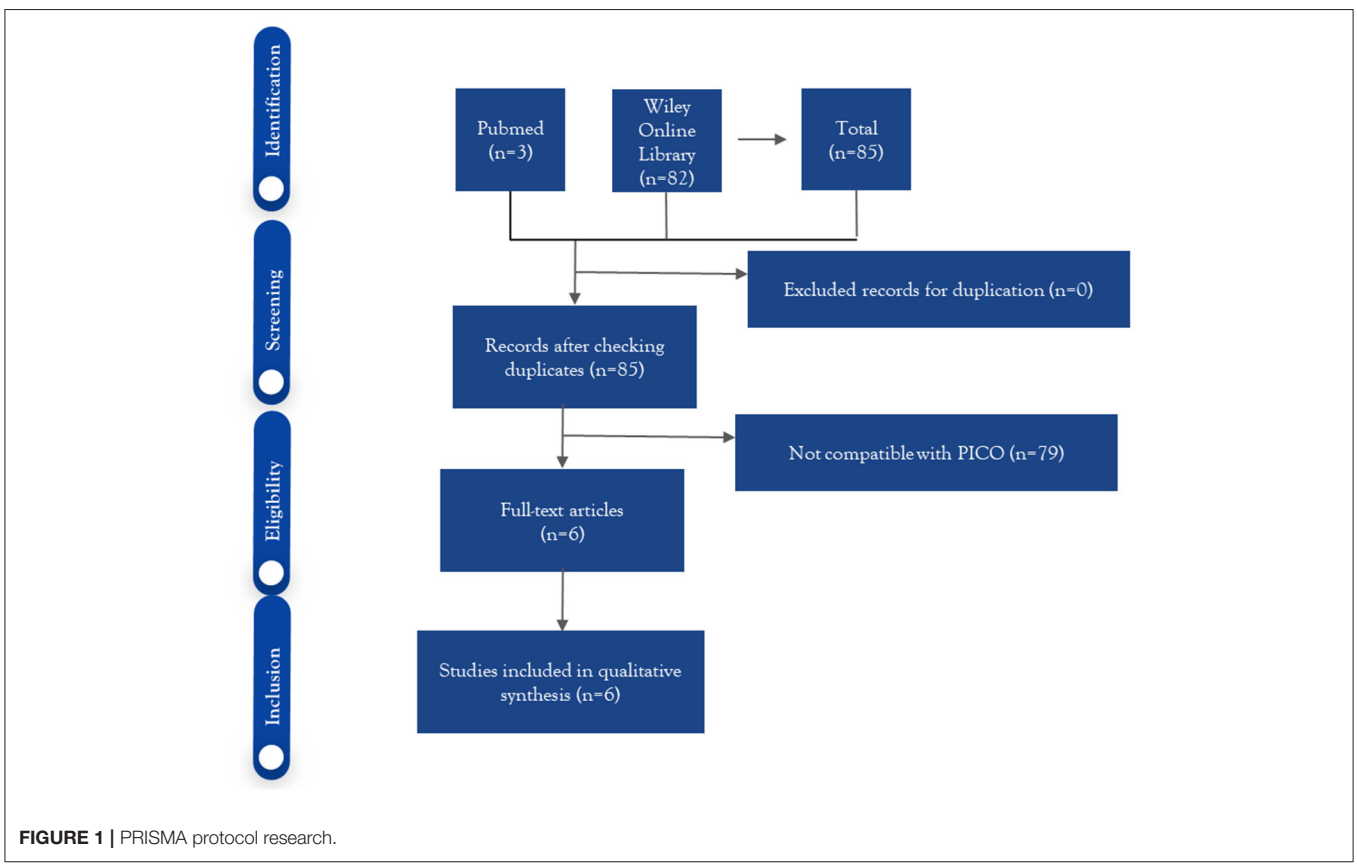

FIGURE 1 | PRISMA protocol research.

TABLE 1 | Summary of literature review.

No	Author/Location, Year	Title	Method	Summary
1	Patricia Navas, Antonio M. Amor, Manuela Crespo, Zofia Wolowiec, Miguel A. Verdugo (Salamanca, Spain, 2020)	Supports for people with intellectual and developmental disabilities during the COVID-19 pandemic from their own perspective	Questionnaire	• Perspective: PwD • People who live in certain neighborhoods have less natural support, while those who live with families rely heavily on it. • Participants also lack the support they deem necessary. • People with disabilities also provide support to others. • Even though Pwd has received assistance during the lockdown, it must be ensured that proper support is provided wherever they live.
2	Lila Kossyvaki (Greece, 2021)	Autism education in Greece at the beginning of the 21st century: reviewing the literature	Scoping review	• Perspective: PwD Child, Family, teachers, society • Themes related to an autistic individual (i.e., the voice of autistic individuals and intervention studies), the family around them (i.e., the role of family and stigma), the role of teachers (i.e., teacher training and teacher stress levels), and the wider society (i.e., parent-teacher collaboration, the medical/deficit model of disability and inclusion) emerged from the review. • The above themes are discussed in the light of the cultural characteristics of Greece and the recent economic crisis the country underwent as well as similar findings from other European countries.
3	Laura Crane, Jade Davies, Anne Fritz, Sarah O'Brien, Alison Worsley, Anna Remington (England, 2021)	Autistic young people's experiences of transitioning to adulthood following the Children and Families Act 2014	Qualitative (online survey and/or interviews)	• Perspective: PwD • A sample of young people reported varied experiences regarding the help and support they received and how much of a say they had regarding the choices and support available to them. • The types of schooling they accessed played a role here: young people in mainstream schools highlighted particular challenges in accessing appropriate support. However, many young people in special schools said they felt well supported. • Parental advocacy was crucial for all young people. • The need for the development of general life and self-advocacy skills was apparent, however, especially in preparing young people for life after school. • Encouragingly, most of our participants were generally happy with their current situation, despite identifying several areas for further improvement. Overall, the results highlight the importance of listening to? And learning from? Autistic young people, throughout their educational journeys and especially as they transition to adulthood.
4	Simone Reinders, Marleen Dekker, Jean-Benoît Falisse (2021)	Inequalities in higher education in low- and middle-income countries: A scoping review of the literature	Scoping review	• Findings The review highlights key elements for policy-makers and researchers: (1) the financial lens alone is insufficient to understand and tackle inequalities since these are also shaped by human and other non-financial factors; (2) sociocultural constructs are central in explaining unequal outcomes; and (3) inequalities develop throughout one's life and need to be considered during higher education, but also before and after. The scope of inequalities is wide, and the literature offers a few ideas for short-term fixes, such as part-time and online education. • Finally, they should consider relevant contextual determinants of inequalities.
5	Robert A Moffitt, James P. Ziliak (US, 2020)	COVID-19 and the US Safety Net	Literature review	• Perspective: Society • This shows that the safety net response to employment losses in the COVID-19 pandemic largely consists of increased support from unemployment insurance and food assistance programmes and inadequate response compared with the magnitude of the downturn. • This study discusses options to reform social assistance in the United States to provide more robust income floors in economic downturns.
6	Amanda Coles, Doris Ruth Eikhof (Canada, 2021)	On the basis of risk: How screen executives' risk perceptions and practices drive gender inequality in directing	Qualitative	• Perspective: Society • Perceptions of employers/decision makers in the industrial world regarding the safety risks of persons with disabilities affect the inclusiveness of providing opportunities for persons with disabilities to work.

7. Few have access to scholarships because most PwDs in special schools are prepared for jobs that can generate immediate income;
8. Special schools are not ready to become inclusive because they are not well connected with the industry or appropriately facilitated so that competitiveness capacity for work has not been optimized;
9. The abilities and expectations are not the same between companies and PwDs;
10. Limited support from the government for companies to accept PwDs to work;
11. Lack of volunteers who can accompany college students and develop teaching methods that could influence the quality of students, including technical skills to work;
12. Lack of readiness of lecturers to teach PwDs;
13. Lack of peer treatment for accepting PwDs;
14. Types of disabilities with substandard intelligence should be provided with suitable jobs.

From the in-depth interview, information was obtained that since 2019, the Ministry of Education and Culture has prepared zoning with one inclusive school at all levels that can accept people with disabilities so that people with disabilities enter the world of education leading to higher education. Unfortunately, however, during the pandemic, there is no news yet.

The results obtained from the literature review, followed by in-depth interviews, showed the factors that influenced the inclusiveness of PwDs at work. The interactions of those factors are presented in the causal loop diagrams as follows (see **Figure 2**):

From the causal loop, three loops were identified. The three loops are seen in forming a cycle in the same direction, namely clockwise or counterclockwise.

Loop 1

Based on the Loop 1 (see **Figure 3**), socialization from the government regarding the policy to accept workers with disabilities in companies would increase cooperation between companies and companies with institutions and individuals who have a disability status. The involvement of workers with disabilities in a company can initiate other companies to accept workers with disabilities or indirectly socialize PwDs with particular abilities, showing their ability to contribute to a company.

Loop 2

In Loop 2 (see **Figure 4**), an increase in PwD's income also affects their motivation to get involved at work, which can reduce the high unemployment rate of PwDs. In other words, PwD's contribution to a company will increase, and they have the same right to a career to develop and earn an appropriate income.

Loop 3

In Loop 3 (see **Figure 5**), PwDs with a history of low poverty rates determine the number of PwDs who can become students in education. Their easy access to education will increase their level of education. The level of education in PwDs will determine how much they are capable of and how they work, for example, reducing unemployment. A low PwD unemployment rate will increase income and reduce poverty.

DISCUSSION

Loop 1: Socialization → Cooperation → Company → PwD Workers → Socialization

Through loop 1, socialization from the government regarding the regulation of employing PwDs will provide increased cooperation to government and non-government institutions. As in the data obtained in the 2015–2019 Rencana Aksi Nasional Hak Asasi Manusia/National Action Plan for Human Rights (RANHAM) related to the aspect of cooperation, there are at least 40 ministries/agencies and all provincial and district/city governments identified as institutions that have tasks, responsibilities, and roles related to improving the welfare of PwDs. In addition, there are five other ministries/institutions, namely Ministry of Youth and Sports, Ministry of Tourism, Ministry of Women's Empowerment and Child Protection, the Central Bureau of Statistics and the National Team for Acceleration Poverty Reduction (TNP2K), that have the potential to play a role but are not yet included in the RANHAM as stakeholders who fight for PwDs (3).

Based on the results of the Focus Group Discussion (FGD) SMERU Research Institute, the central government budget allocation for disability-related activities in 2017 was IDR 309 billion. The budget is mainly spread across the Ministry of Social Affairs, the Coordinating Ministry for Human Development and Culture, and the coordinating Ministry for Politics, Law, and Security. The distribution of the budget is uneven between ministries because around 90% is given to the Ministry of Social Affairs (3). This could be due to budget constraints and commitment to determining budget allocation priorities.

In addition, the environment, on the social aspect of humanity, which consists of donor agencies and non-governmental organizations or non-governmental organizations (NGOs), can adopt competitive or cooperative interactions between organizations. Collaboration between NGOs in providing assistance and information disclosure had a positive and direct effect on government policy (22). In other words, the more successful the government in each of its policies requires more cooperation between NGOs. With the strengthening of the level of NGO cooperation, the utility of organizations and donors increases, so this type of NGO interaction is also beneficial for donors. NGO competition provides the possibility of creating a higher level of social welfare with less budget consumption (22).

This collaboration can increase the perceptions of other job seekers about companies that employ PwDs. The social impact perspective is an inclusive practice that can be an example for other companies. A survey of various full-time employees across the US reported that job seekers tend to prefer inclusive employers, with approximately 80% of respondents identifying

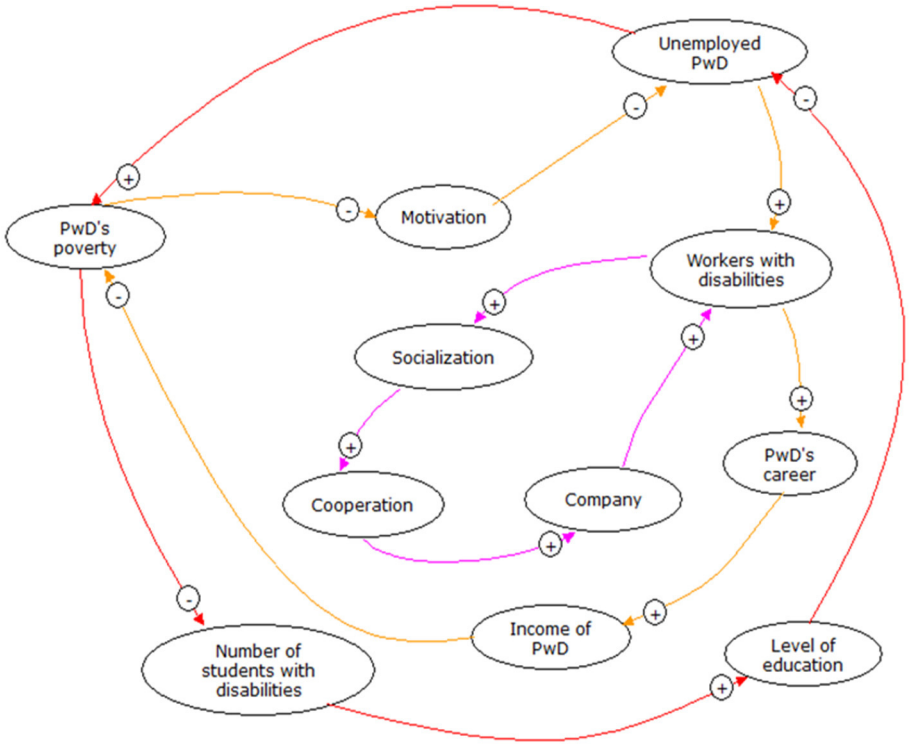

FIGURE 2 | Casual loop inclusiveness of people with disabilities at work. The "+" symbol indicates unidirectional causality, and the "−" symbol in the arrow represents the opposite directions of causality.

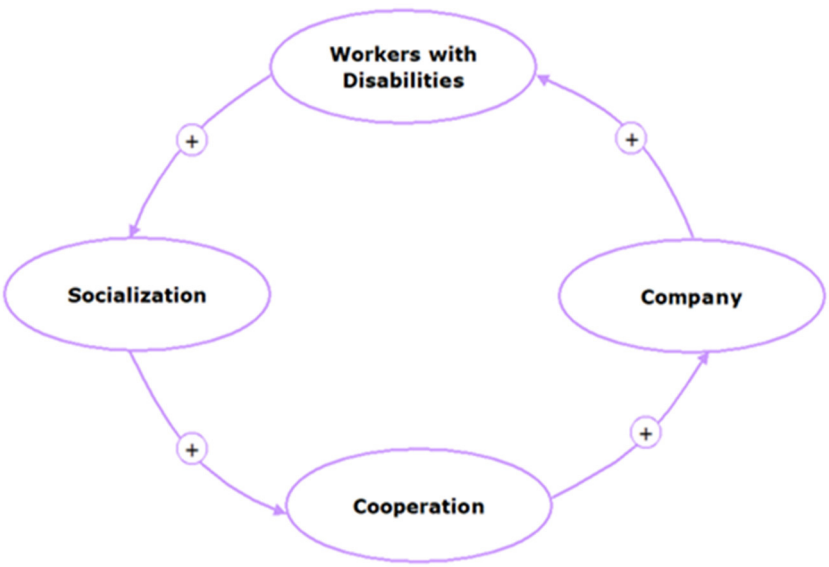

FIGURE 3 | Loop 1: Socialization → cooperation → company → PwD → workers → socialization. The "+" symbol indicates unidirectional causality, and the "−" symbol in the arrow represents the opposite directions of causality.

inclusivity as an important factor in choosing an employer (23). Research has also shown that consumers prefer companies that employ individuals with disabilities (24). Various beneficial results related to the presence of workers with disabilities provide confidence and the notion that workers with disabilities are an untapped resource or a hidden asset (24–26).

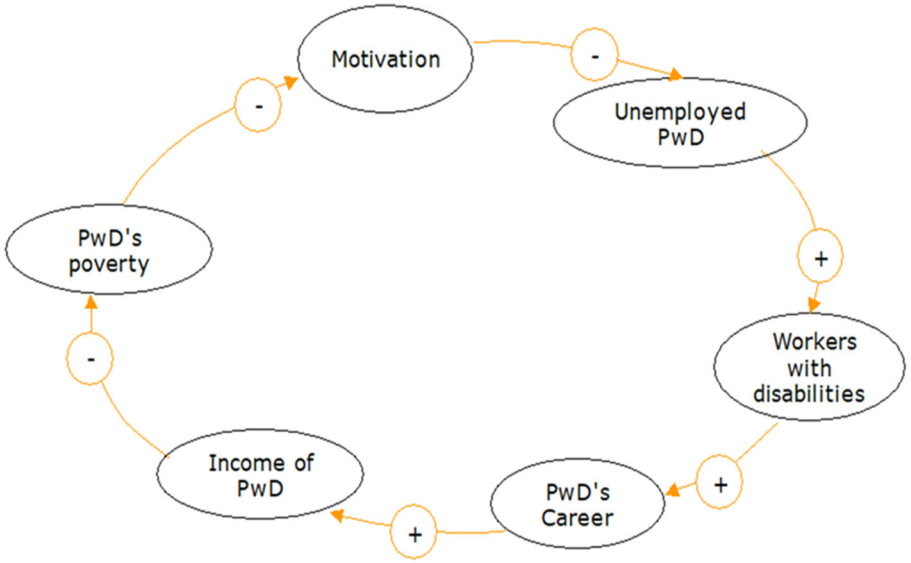

FIGURE 4 | Loop 2: PwD income → Motivation → PwD unemployment → PwD workers → PwD careers → PwD income. The "+" symbol indicates unidirectional causality, and the "−" symbol in the arrow represents the opposite directions of causality.

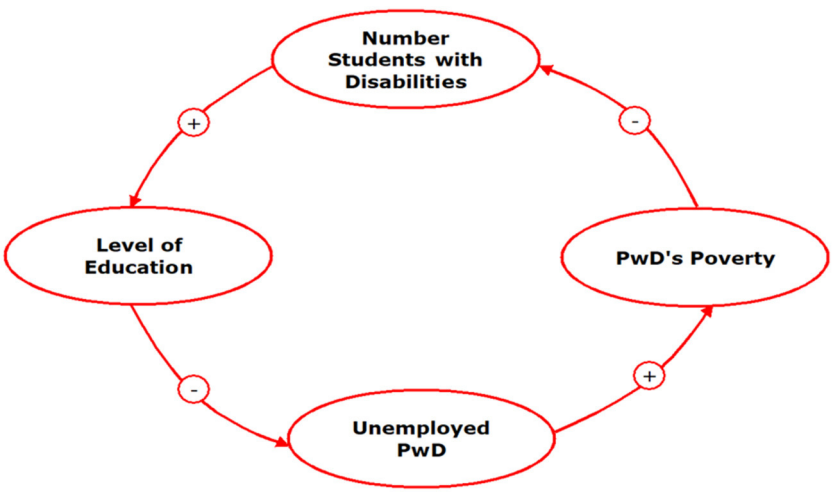

FIGURE 5 | Loop 3: poverty → number of PwD students → education level → PwD unemployment → poverty. The "+" symbol indicates unidirectional causality, and the "−" symbol in the arrow represents the opposite directions of causality.

There was a relationship between good leadership and the level of discrimination, job satisfaction, and the need for recovery felt by disabled workers. In addition, good leaders display responsiveness to community calls, such as in terms of supporting PwDs, providing fair treatment, exploring potential, meeting the needs for psychological security, self-esteem, socializing, and changing negative views of themselves, and being able to turn them into employees with self-respect, confidence, and attachment (27).

However, attention to PwDs at work is still not well integrated. Not only does it require employment, but physical conditions that have limitations also require the support of facilities that can increase PwD mobility, such as public transportation and special aid. There were 71 business companies in six provinces in Java and Bali that employ PwDs, only about 7.04% of companies provide public transportation facilities for disabled workers (28). Furthermore, based on the results of a survey by Indonesia Corruption Watch (ICW) to 800 PwDs conducted randomly in four cities (Bandung, Solo, Makassar, and Kupang), only very few PwDs (9%) have ever received assistive devices. The majority (91%) of PwDs in Indonesia have never received assistive devices from the government (29).

The socialization of regulations to create employment opportunities for PwD workers could provide PwDs with a

place to work and adjust the workload to the level of disability possessed by individual PwD workers. PwDs still have lower levels of work, job security, income, salary satisfaction, job satisfaction, and quality of work–life compared to people without disabilities (27).

Loop 2: PwD Income → Motivation → PwD Unemployment → PwD Workers → PwD Careers → PwD Income

Motivation is a force that exists within and from outside a person and generates enthusiasm and perseverance (30). Work gives a person the opportunity to earn income, establish social relationships, and build socio-political status, which is also crucial for PwDs (31). Many PwDs are able and willing to work to be financially independent and contribute to the development of the wider community and society (32).

A career path is a path that connects one position to another. Career paths are needed both in private and public companies that are oriented toward work challenges. A company will provide and organize a work program to determine career paths to encourage employees to improve at work through a series of experiences and tasks that can be carried out in one or more organizations (33). Career path for PwDs must also be considered, as an employee's right in their work.

Career development involves two-way connections, namely vertical (e.g., responsibilities at work) and horizontal (e.g., existence of different competencies at the same level or job rotation). Both of these factors will affect the career development of each employee but also require additional special skills. Based on this, PwDs who work often feel that there is no justice in career development in companies with their physically limited abilities. It discriminates them from having access to jobs, and they are often given low-status jobs (34).

Companies are concerned about the limitations of the disability and generalize that to a PwD's ability to work. The existence of barriers to the career development of disabled workers will affect how they obtain a job and the income they receive. Opportunities to get promotions and job rotations are also limited (35).

The existence of limitations for PwDs causes them to be vulnerable to being classified as poor. The 2013 Riset Kesehatan Dasar/Basic Health Research Survey (Riskesdas) found that the prevalence of disability was higher at a lower ownership index. For example, 15.2% of PwDs are in the lowest wealth quintile index (4).

Loop 3: Poverty → Number of PwD Students → Education Level → PwD Unemployment → Poverty

In Loop 3, it was shown that poverty can affect the ability of students with disabilities to attend school. Low-income families find it difficult to send their family members to school because of the family's economic limitations. Moreover, it could be that the main priority is not to get an education but to fulfill the family's basic needs, considering that the family's economy is very limited. This will undoubtedly affect the level of education for PwDs of school age. Furthermore, the low participation of PwDs in schooling in general will certainly affect their education level. For example, in Greece, it was reported that several autistic children did not have access to appropriate education or did not attend school (36, 37).

Several factors affect the level of education for PwDs:

Participation

Today's autistic individuals have limited involvement in their education and life decisions, let alone participation in research (38). From the author's personal experience of interviews with parents of children with autism in Greece, parents seemed very reluctant to let their children participate in the study. This reluctance may be the fear that with their children's participation, they will become aware of their autism diagnosis, which is often kept secret from them (38).

Family Role

The family, in its broad form, seems to play an essential role in the education of autistic children in Greece (38). The ability of parents to discipline their children is related to the progress of the child's development. Great family values should also be a concern, because not only parents but also grandparents and other relatives play an essential role in raising children in Greece (39).

Teacher's Role

Teaching children with autism has been found to cause considerable stress, even for special education teachers (40). It was extensively importance of parent-and-professional partnerships, especially in special needs individuals (41).

Stigmatization

One-third of parents do not disclose to their co-workers that they have an autistic child, mainly because they fear stigmatization or because this will affect their promotion opportunities (42). Fathers tend to be more secretive about having a child with autism than mothers. The extent of stigmatization of autistic individuals in Greek society found that several teachers believe that other students should not know about the presence of an autistic person (43).

Inclusive Education

Peer relationships play an essential role in the successful inclusion of students with autism in schools and the wider community (44). There is an interesting paradox about inclusion in Greece. On the other hand, studies show that teachers consider inclusion essential to minimize the impact of stigma on children with Special Educational Needs and Disabilities (SEND) and their families. On the other hand, many teachers think that students with autism may receive a better and more appropriate education in special schools (43, 45, 46).

Most Greek teachers thought that special schools seemed more suitable for them because they should receive social skills education rather than follow a curriculum that focuses on academic skills (47). The same thing happened in Indonesia. In principle, the curriculum is the same as the regular school curriculum, but in special schools it is more adapted to the

abilities of the students. The basic competencies for children in special schools are more adapted to their disabilities, and each disability has different basic competencies (48). Teachers seem unclear about their responsibility to teach autistic children, especially in public schools. Many of them held onto some misconceptions about autism and stated that they needed more training. Teaching children with autism tends to increase teacher's stress levels, but appropriate training has been found to reduce their stress levels.

Inadequate education levels for PwDs will affect their acceptance of job searches, especially if they do not have sufficient skills. In addition, a limited level of education will reduce the bargaining power of the intended job location. In the end, the level of employment of PwDs will also be limited and will affect their economies in the future. The high unemployment rate causes problems in the economic and social sectors, such as poverty.

Living in poverty can increase the likelihood of students with disabilities becoming unemployed and having limited secondary education. The United States seeks to address educational problems and economic inequality for PwDs through federal legislation. Therefore, it is recommended that there be direct policies to address educational inequality for PwDs so that they are expected to improve their daily lives (49).

Studies have shown that poverty is related to employment in terms of disability. In a study in India, PwDs can only obtain an education if it is supported by accessible educational facilities, roads, and adequate transportation facilities and information. For that, both education and work require accessibility. These things will not happen without the support of adequate regulations and policies. To obtain these regulations, it is necessary to build awareness and good communication with the parties involved. Therefore, five things need to be considered simultaneously: employment, education, accessibility, regulation/policy, and good communication in India (50).

India has a 3% employment quota policy for PwDs, namely people with orthopedic, visual, and hearing disabilities. This policy can benefit PwDs in finding work. Although this policy has been established, in reality, it has not run optimally (50). The quota has not been fulfilled in full due to the limitations of PwDs who can fulfill the requirements. This quota may be fulfilled in the public sector, especially in government offices. However, for the private sector, a more effective regulation of employment without discrimination is needed. Overall, the main issues that need attention for the employment of PwDs are those with disabilities who do not receive education in schools, colleges, or universities and who are also not involved in skills development programs (50).

The Covid-19 pandemic has put all countries at the same starting point; no one is unaffected, and no government is ready to deal with it, especially in the economic field. It can be seen that the impact of the Covid-19 pandemic has also affected developed countries, such as the United States. The United States has social insurance programs for PwDs, such as disability insurance, Medicare, and additional security income. However, social insurance for PwDs does not assist those who are experiencing an economic downturn. The unemployment rate in the United States at the beginning of the pandemic rose sharply, especially during the Great Recession. During 2020, there was a decline in income for necessities. For this reason, it is necessary to reform options for US safety nets, especially for PwDs, including expanding program access and generosity to unprotected and unprotected populations during good and bad economic times, mainly through social assistance programs (51). In Indonesia, there was training for PwDs in the worker card program held by the government, so that PwDs will become more productive. As a result of the Covid-19 pandemic, there has been a reduction in wages, especially for PwDs with limited mobility. Therefore, with the training from the program, it will increase the value-added skills for PwDs. So the expansion of this program has become a necessity (52).

PwDs workers experienced reduced hours and experience higher levels of financial stress in the pandemic situation (53). Working-age adults with disability were particularly disadvantaged by the financial impact of the COVID-19 lockdown in the UK. This situation strengthens the study findings, namely the interaction between factors and causal interaction patterns that affect the inclusiveness of workers with disabilities in pandemic situations. This condition applies universally on an international scope until the World Health Organization (WHO) has indicated this. Disabled people experience entrenched structural disadvantages, including barriers to accessing health care, increased poverty, lower employment, and lower education levels compared to the general population (54–57).

Although the objectives of this study have been achieved (to identify various factors and causal interaction patterns that affect the inclusiveness of workers with disabilities in pandemic situations), we are aware of the limitations of our study that focus on causal loops and have not expanded studies with quantitative approaches to surveyed PwDs workers to explore their perceptions of those affected by the pandemic. For this reason, further research can be carried out using a quantitative analysis approach.

CONCLUSION

1. The identified factors of inclusivity of people with disabilities in the work sector during the Covid-19 Pandemic are socialization, cooperation, company, PwD workers, PwD income, motivation, PwD unemployment, PwD career, poverty, number of PwD students, education level, and PwD unemployment.
2. Disability was proven to be significantly affected during the pandemic, impacting the job acceptance sector.

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

This study was approved by the Research and Community Engagement Ethical Committee Faculty of Public Health Universitas Indonesia (Ethical Approval: Ket- 321/UN2.F10.D11/PPM.00.02/2020).

AUTHOR CONTRIBUTIONS

DA conceived the manuscript idea, supervised, and funded the article. DA, NA, SB, AL, and TN contributed to conception and design of the study and performed the causal loop. All authors performed the literature review, wrote the first draft of the manuscript, contributed to manuscript revision, read, and approved the submitted version.

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