Public perspectives on health and wellbeing

Edited by
Anat Gesser-Edelsburg, Abhishek Ghosh, Michal Grivna
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Public perspectives on health and wellbeing

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Role of the Media in Health-Related Awareness Campaigns on Perception of COVID-19: A Pre-post Study in the General Population of Pakistan

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Medical preparedness and community education are the most valuable preventive tools for combatting the COVID-19 pandemic. This study aims to assess the role of media public health awareness campaigns on the knowledge of the general population about COVID-19 in Rawalpindi, Pakistan. A quantitative study using a pre-post design among 384 respondents was conducted. A structured questionnaire was administered to the participants twice: The first response (t_1) from participants was filled in during the 1st week in February 2020 before any confirmed cases were reported in the country, and the second response (t_2) was completed 1 month after the first case detection in Pakistan (March 2020). Media health awareness campaigns were launched just after the detection of the first case in Pakistan. Exposure to the media and knowledge relating to COVID-19 increased over time. Whereas, only a quarter of respondents judged the isolation of suspected cases in quarantine to be important to prevent the spread of infection in society at t_1, more than half did so at t_2. Socio-demographic characteristics were not significantly associated with knowledge (gains). However, more frequent use of electronic media is associated with greater knowledge gains from t_1 to t_2. The findings of this study provide evidence that awareness and knowledge related to COVID-19 symptoms and preventive measures increased significantly over time. The increased frequency of following the media indicates that health awareness campaigns are important for enhancing the knowledge of the general public regarding COVID-19.

Keywords: health communication, health education, community education, electronic media, SARS-CoV-2

INTRODUCTION

On 30 January 2020, the World Health Organization (1) declared the Novel Coronavirus Disease 2019 (COVID-19) outbreak to be a global public health emergency. Coronaviruses are a microbial source of infections in individuals, with a spectrum of activity associated with the common cold, Severe Acute Respiratory Syndrome (SARS), and Middle East Respiratory Syndrome (MERS) (2). The outbreak of a pneumonia of unknown cause was observed in Wuhan, China, in December

2019 where a novel coronavirus (SARS-CoV-2) was isolated from patients in January 2020 (3). This outbreak—and the associated strict isolation—attracted global attention due to health communication by the media networks. The movement of people along the road passage from Iran and air travel from other countries brought the virus to Pakistan, which confirmed its first case on 26 February 2020 (4). The number of confirmed COVID-19 cases in Pakistan was 523,011 on 19 January 2021, with 11,055 confirmed deaths (5).

Medical preparedness and community education are the most valuable preventive tools for combatting the pandemic (6, 7). The media has already been serving as an important source of health education and promotion in our societies for decades (8). Health-related communication campaigns in the media have aimed to change the health behavior of the population by creating awareness and promoting prevention, such as hand hygiene practices and immunization coverage (8–10). Health campaigns are categorized into typical and digital technology use campaigns. Typical communication involves the use of different media channels (e.g., print media or electronic media), whereas digital technology communication may involve the use of mobile phones and internet web search engines (8). Health communication plays a vital role in behavioral changes (11) and may, finally, result in modifications in the awareness, attitudes, and practices of the targeted audience for improving health.

After the report of first case in Pakistan, the government of Pakistan, in collaboration with the WHO, established isolation units in leading hospitals, set up screening facilities at border entry points, seaports and airports, facilitated quarantine areas at selected places, provided personal protective equipment for healthcare professionals, and enforced lockdown in cities to break the chain of infection (12).

In Pakistan, the media started to report about the epidemic when it first appeared in Wuhan, but its reporting increased drastically, with more focus on preventive measures, after the first reported case on 26 February 2020 (4). Within the national action plan to combat COVID-19, the Pakistani government developed a national risk communication and community engagement strategy. This strategy included dissemination of COVID-19 related information to the general public through media. The national website on COVID-19 provides information on awareness along with morbidly, mortality, and testing statistics of the country on daily basis. Awareness campaigns launched nationally were categorized into typical and digital technology use campaigns: Typical communication involved the use of newspapers, television, and radio, whereas digital technology communication covered the use of mobile phone messages and internet web search engines. Consultation on COVID-19 was provided by a national helpline and telemedicine departments of the medical universities (5, 13).

The COVID-19 related awareness campaign in Pakistan emphasized on the symptoms of the disease, preventive measures, and the importance of physical distancing (5, 13). Symptoms of a coronavirus disease may appear within 2–14 days after viral exposure. The initial symptoms may include fever, cough, headache, sore throat, shortness of breath, and rapid heartbeat, with complications of pneumonia and organ failure.

Treatment options are only supportive because no targeted anti-viral therapeutics are available at present (14). The elderly, persons with diabetes, and immune-compromised people are the most vulnerable groups when infected with COVID-19 (15). The general public has lack of access to vaccination against COVID-19 as it is not yet available in Pakistan (16). Protective measures adopted by the general population should include frequent handwashing, use of hand sanitizers, wearing face mask, avoiding close contact with sick people, and physical distancing practices (17).

Correct perception of population is essential to ensure good preventive practices for control of corona pandemic (18). Population based media exposures reported positive or prevent negative changes in behaviors (8). Health-related awareness campaigns regarding polio vaccination, family planning, and acquired immunodeficiency syndrome prevention were successful in Pakistan in creating awareness among masses and encouraging people to use healthy behaviors (19). Given this backdrop, there is an urgent need to investigate the role of media as an awareness creator regarding COVID-19 signs, symptoms and protective measures to prevent its transmission.

Our study is based on the Knowledge Gap Hypothesis. This hypothesis proposes that knowledge is disseminated in the society on the basis of socio-economic indicators. The philosophical stance of the knowledge gap hypothesis described that people with better financial status may assimilate media information more rapidly than lower financial status (20). The socio-demographics association with awareness was analyzed in this study. The objectives of the study were to assess the role of media health-awareness campaigns on the general population's perception and knowledge of COVID-19 in Rawalpindi, Pakistan.

METHODS

Study Design

A quantitative research method based on a pre-post study design was used to collect data from the general population in Rawalpindi, which is the fourth most populous city in Pakistan and located in Punjab province (21). Rawalpindi is adjacent to Pakistan's capital of Islamabad and is an important administrative, commercial and industrial hub. In addition to urban settlements, it comprised of numerous suburban housing developments that provide residence to workers in Islamabad. Being close to the country's capital, Rawalpindi has active media networks and a large number of cable TV service providers.

Data Collection

Data was collected during the first wave of the COVID-19 pandemic. At the time of the first wave, Rawalpindi was among the top three cities with highest numbers of COVID-19 cases in Punjab (22). At that time, the country was experiencing a complete lockdown except for healthcare facilities and pharmacies which were allowed to practice. This was the reason that the present study was conducted in a community pharmacy of Rawalpindi. Secondly, community pharmacies were the places that were frequently visited by the general public

for prescription refilling for relatives, health accessories, and cosmeceutical purchases. Thirdly, the visitors' record including their contact information was well maintained at the pharmacy, which was essential for the post-phase of the study. Nonetheless, there were some limitations in selecting the pharmacy as study site. This particular location may result in an exclusion of certain groups of people (e.g., people with good health or people who cannot afford to go to a pharmacy). However, this was the most suitable location at the time of the pandemic and its associated lockdown.

The respondents were regular clients of the community pharmacy in Rawalpindi, who visited every month. The adult population using the media as a source of health awareness, not currently labeled as patients by any prescriber, and being willing to participate were included in the study.

Face-to-face interviews were conducted by the first author in the sitting area of the pharmacy (which was arranged on the request of researchers in a corner of the pharmacy). The average time for each interview was 12 minutes. The response rate at t_1 was 100%. Paper-and-pencil questionnaires were filled by the interviewer. After the interview, the respondents were informed about the second phase (t_2) of data collection and their willingness and contact information were asked for contacting them again. The respondents were informed about the timing of the second phase through phone or SMS message. Most of the interviews were conducted at the pharmacy at respondents' convenience whenever they visited the pharmacies for prescription refilling for relatives, buying health accessories, and cosmeceutical purchases. However, seven of the respondents could not visit the pharmacies and gave their responses on phone. The non-response rate was 3% in the second phase and 2% of questionnaires were incomplete. For that reason, the data of 384 respondents were included in the final analysis.

Sample Size and Sampling Technique

The sample size of 384 was calculated on the hypothesis that knowledge prevalence related to covid-19 sigs, symptoms and preventive measure's (P) would be 50%, with an allowable error (d) of 5% and a confidence level of 95% ($z = 1.96$). A non-response rate of 5% was added and the final sample size was 403. The technique used for the data collection was systematic random sampling, because the public was rationally similar. Each wave of the study needed to be completed within 1 week. As the average population visiting the pharmacy every week was $n = 1,920$, the sampling interval was $k = 5$. The first respondent was chosen in February by using a software method for simple random sampling. The first respondent selected was visitor number 3. Then, by the addition of participants at the regular interval ($k = 5$), the sample size was completed. The same participants completed the second response.

Items of Interest

A self-designed structured questionnaire (**Supplementary Appendix 1**) was used as toll of data collection. The tool consisted of three sections; the first section comprised of information on the socio-demographics characteristics of the respondents including age, gender, marital status, place of residence, level of education, and family monthly income. The second section was related to the history of the frequency of using different types of media for information seeking about COVID-19. The respondents were asked about the frequency of use of different types of media such as social/digital (Facebook, WhatsApp, twitter, internet, websites of public bodies, health portals), electronic news portals (television), and print media (newspaper, magazines, brochures) for public health awareness related to COVID-19. The third part of the questionnaire was related to knowledge regarding COVID-19 symptoms, complications, and preventive measures to be adopted regarding COVID-19, and the effect of lockdowns on social isolation. The respondents were asked to answer whether several statements were correct ("Yes", "No", or "Don't know").

Correct statements were valued with one point each and summed (without weighting) in three subscales related to knowledge (general, symptoms, and preventive measures) and an overall total scale (ranging from 0 = "No knowledge" to 19 = "Full knowledge"). The subscales included a five-item subscale related to general awareness (i.e., coronavirus is contagious, spread through droplets, spread through coughing and sneezing by an infected person, coronavirus treatment is only supportive, and no vaccine is available), a six-item subscale on symptoms and complications (i.e., fever, cough, body aches, shortness of breath, pneumonia, organ failure), and an eight-item subscale on preventive measures (frequent handwashing with soap and water, following cough and sneeze etiquette, avoiding social contact with people, use of face masks, use of hand sanitizers, isolation of suspected cases, their perceptions regarding lockdown as preventive measures, for example, lockdown helped people in following physical distancing and lockdown helped in protecting people from the spread of infection). The questionnaire's construct validity and reliability were evaluated by factor analysis and Cronbach's alpha, respectively. The Kaiser-Meyer-Okin measure was 0.89 with significant Bartlett's test. Three components were extracted to measure the underline construct. The reliability Cronbach alpha value was 0.899 for the subscale of general awareness, 0.922 for the subscale of symptoms and complications, and 0.873 for the preventive measure subscale.

Media Awareness Intervention

This study investigates the role of the media in shaping the perceptions of the general population visiting a community pharmacy in Rawalpindi, Pakistan, toward COVID-19. The first response from participants was filled out during the 1st week of February 2020 before any confirmed cases were reported in Pakistan (t_1). Media awareness and prevention campaigns for COVID-19 started just after the detection of the first case on 26 February 2020, and reached a peak in March 2020 in Pakistan. Lockdown in the country also created curiosity related to COVID-19 in the general public (23, 24). The national disaster management authority, Pakistan's telecommunications authority, as well as electronic and print media were continuously providing awareness alerts and preventive communications. The health education and prevention interventions by the media comprised of

comprehensive education on coronavirus awareness (e.g., current spread, transmission routes, or symptoms of COVID-19), along with the screening and preventive measures (individual measures to protect against infections, hygiene regulation, dealing with mental stress during the COVID-19 lockdown) that needed to be adopted to stay healthy and safe from COVID-19 (13). During the last week of March, the second response was collected from each participant (t_2), giving an 8-week interval between the two surveys.

Data Analysis

The data was analyzed using SPSS version 21. We applied descriptive and inferential statistical methods. Frequencies and percentages were computed for summary statistics. We used correlation tests for the association between the different media types. The research aims to describe the potential change in population perceptions regarding COVID-19, following media campaign exposure during February and March 2020. Statistical tests such as the paired t-test and chi-square test were used to assess changes in the population's perceptions during subsequent months.

The factors associated with knowledge were assessed using three linear regression models. The dependent variables were the overall scores for knowledge related to COVID-19 at t_1 and t_2, and for the knowledge gains over time (between t_1 and t_2). Independent variables were the variables related to media use and socio-demographic characteristics, such as those described in **Table 1**, except for education, which was categorized as a binary variable ("12 years or fewer" vs. "13 years or more") to allow for large enough sub-groups in the regression models. The R2 was calculated as the coefficient of determination.

Ethical Considerations

The study protocols were reviewed and approved by the Institutional Ethical Review Board, University of the Punjab (143/IERB/PU). The investigation's objectives were clearly explained to participants before the questionnaires were administered, and written informed consent was obtained. Respondents were informed about the ethics and their right of voluntary participation. The respondents were guaranteed confidentiality and anonymity of their responses in the publication.

RESULTS

Sociodemographic Characteristics

The majority of participants were middle-aged. About 80.2% of respondents were male and 68.5% were married. A majority, 62.8%, of the participants did not have a university degree and 60.0% were earning <50,000 rupees per month. Almost equal proportions were from rural and urban areas (**Table 1**).

Use of Various Media Channels

The research investigation involves filling out questionnaires, both before (t_1) and after (t_2) the first reported case of COVID-19 in Pakistan. The media were considered to be an information provider and awareness creator. People use different types

TABLE 1 | Sociodemographic characteristics of respondents ($n = 384$).

Sociodemographic characteristics	n (%)
Age (in years)	
16–30	59 (15.4)
31–45	62 (16.1)
46–60	178 (46.4)
61–75	85 (22.1)
Gender	
Male	308 (80.2)
Female	76 (19.8)
Marital status	
Currently married	263 (68.5)
Currently not married	121 (31.5)
Place of residence	
Urban	200 (52.2)
Rural	184 (47.8)
Level of education	
<11 years of education	96 (25.0)
11-12 years of education	145 (37.8)
13–14 years of education	96 (25.0)
15–16 years of education	28 (7.3)
>16 years of education	19 (4.9)
Family monthly income (in Pakistani rupees*)	
<25,000	104 (27.1)
25,000–50,000	126 (32.9)
50,001–75,000	112 (29.1)
75,001–100,000	34 (8.9)
>100,000	8 (2.0)

*1 US Dollar = 166.65 Pakistani rupees.

of media—either exclusively or in combination—to acquire information. Different types of media correlated at a low or moderate level for each instance of data collection. However, there was a very high correlation for each type of media when comparing t_1 and t_2. The daily users of social media increased from 46.1 to 54.7% from t_1 to t_2. The proportion of weekly users of social/digital media stayed almost the same. Electronic media (news portals) were the most widely used among participants (62.5% at t_1 and 71.7% at t_2). The use of newspapers and magazines decreased significantly, as 64.3% of respondents were not using them in March compared to 45.1% in February (**Table 2**).

Awareness and Knowledge Related to COVID-19

The first response in February depicts an overall low level of knowledge regarding COVID-19 among participants. At t_1, 37.5% of respondents knew that the coronavirus is a contagious viral disease, whereas 51.8% were aware of the transmittable nature of coronavirus at t_2. The droplet route of coronavirus transmission was known to 29.2% (t_1) and 42.4% (t_2) of the sampled population. That coughing and sneezing of viral material spreads the infection to healthy people was

Type of media	Media use at t_1			Media use at t_2		
	n (%)			n (%)		
	Daily	Weekly	Not follow	Daily	Weekly	Not follow
Social media (e.g., Facebook, WhatsApp)	177 (46.1)	99 (25.8)	108 (28.1)	210 (54.7)	95 (24.7)	79 (20.6)
Electronic media (e.g., television)	240 (62.5)	72 (18.8)	72 (18.8)	273 (71.7)	59 (15.4)	52 (13.5)
Print media (e.g., newspaper, magazine)	150 (39.1)	61 (15.9)	173 (45.1)	97 (25.3)	40 (10.4)	247 (64.3)

TABLE 3 | Correct knowledge related to COVID-19 in February (t_1) and March (t_2) 2020 ($n = 384$).

Variables	t_1	t_2
	n (%)	n (%)
Coronavirus general awareness		
Coronavirus is a contagious viral disease	144 (37.5)	199 (51.8)
Coronavirus spreads via droplet infection	112 (29.2)	163 (42.4)
Coronavirus spreads through coughing and sneezing of the infected person	141 (36.7)	243 (63.3)
Coronavirus treatment is only supportive	87 (22.7)	198 (51.6)
Coronavirus vaccine is available (*wrong statement*)	325 (84.6)	382 (99.5)
Knowledge regarding symptoms of COVID-19		
Fever	105 (27.3)	263 (68.5)
Cough	81 (21.2)	249 (64.8)
Body aches	133 (34.6)	262 (68.2)
Shortness of breath	105 (27.3)	259 (67.4)
Complications of COVID-19		
Pneumonia	76 (19.8)	94 (24.5)
Organ failure	85 (22.1)	126 (32.8)
Preventive measures to be adopted for COVID-19		
Frequent handwashing with soap for 20 s	123 (32.0)	328 (85.4)
Following cough and sneeze etiquette	158 (41.4)	216 (56.3)
Avoid social contact with sick people	109 (28.4)	213 (55.5)
Use of face mask	130 (33.9)	203 (52.9)
Use of sanitizer	139 (36.2)	253 (65.9)
Isolation of suspected cases	109 (28.4)	205 (53.4)
Lockdown effect in countries during COVID-19		
Lockdown helped people in following social distancing	106 (27.6)	225 (58.6)
Lockdown helped in protecting people from the spread of infection	93 (24.2)	211 (54.9)

correctly identified by 36.7% of the respondents initially and that knowledge level had increased to 63.3% in the second response. At t_1, 22.7% of participants knew that coronavirus treatment is only supportive, while 51.6% confirmed this statement at t_2. In February, 15.4% erroneously judged the statement that a vaccine is available to be correct, whereas only 0.5% did so in March (**Table 3**).

Awareness regarding the symptoms of COVID-19 indicated a noteworthy increase in knowledge among participants. At t_1, about one third provided correct responses to all the different

kinds of symptoms, whereas this was about two thirds at t_2. The general public's correct response rate related to complications of COVID-19 was much lower. Fewer than 23% in February and fewer than 33% in March identified pneumonia and organ failure as complications of COVID-19 (**Table 3**).

The results of the questions about preventive measures to be adopted indicated that 32% of respondents were conscious of frequent handwashing in February. This response had increased significantly to 85.4% in March. For all other preventive measures, the correct responses increased as well, but at a lower level, from about one third correct answers to slightly more than half. Whereas, only a quarter of respondents judged the isolation of suspected cases in quarantine to be important for preventing the spread of infection in society at t_1, more than half did so at t_2. The same increase was visible in relation to the statement that a lockdown helps in following social distancing (**Table 3**).

Knowledge Gains Over Time and Associated Factors

The changes within three subscales related to COVID-19 awareness (general, symptoms, and preventive measures), as well as total awareness as the combination of all three subscales, are presented in terms of mean differences in **Table 4**. For all scales, knowledge increased significantly over time.

Using three linear regression models, we analyzed the factors associated with knowledge (all knowledge items combined in one score) related to COVID-19 at t_1, at t_2, and those factors associated with knowledge gains over time (between t_1 and t_2). Socio-demographic characteristics are not significantly associated with knowledge, except for an inverse relationship with income at t_2. Although not significant, people of younger age, female, and living in urban areas had a greater likelihood of better knowledge related to COVID-19 at both t_1 and t_2. Nevertheless, knowledge gains were higher within those groups with lower knowledge levels at t_1. Respondents with a higher educational level had greater knowledge at t_1 and t_2, and also demonstrated greater knowledge gains.

More frequent use of social media and electronic media was associated with lower levels of knowledge in both surveys. Although the use of electronic media is significantly inversely related to knowledge at both t_1 and t_2, this does not hold for the changes in knowledge over time: more frequent use of electronic media is associated with higher knowledge gains from t_1 to t_2 ($B = 0.522$, $p = 0.018$). The variance explained by the variables included in the models is <5% for all three models (**Table 5**).

TABLE 4 | Knowledge related to COVID-19 in February (t_1) compared to March (t_2) 2020 ($n = 384$).

Variables	Time	Mean	SD	Mean difference	p-value
Coronavirus general awareness (5 items)	t_1	2.11	1.43	0.97	<0.001
	t_2	3.08	1.49		
Symptoms of COVID-19 (6 items)	t_1	1.52	2.20	1.74	<0.001
	t_2	3.26	1.49		
Preventive measures to be adopted (8 items)	t_1	2.53	2.69	2.30	<0.001
	t_2	4.83	1.71		
Total (19 items)	t_1	6.16	5.80	5.02	<0.001
	t_2	11.18	3.71		

TABLE 5 | Factors associated with knowledge (gains) related to COVID-19 ($n = 384$).

	t_1			t_2			Knowledge gain (t_1 to t_2)		
	B	T	p-value	B	T	p-value	B	T	p-value
Age	−0.327	−1.056	0.292	−0.108	−0.553	0.581	0.164	1.016	0.310
Gender	1.021	1.365	0.173	0.639	1.351	0.178	−0.482	−1.234	0.218
Residence	−0.842	−1.413	0.158	−0.722	−1.905	0.058	0.067	0.214	0.830
Education	0.263	0.375	0.708	0.335	0.756	0.450	0.032	0.088	0.930
Income	−0.186	−0.570	0.569	−0.465	−2.210	0.028	−0.293	−1.687	0.093
Social media	−0.305	−0.869	0.385	−0.037	−0.158	0.875	0.042	0.214	0.831
Electronic media	−0.961	−2.462	0.014	−0.575	−2.156	0.032	0.522	2.373	0.018
Print media	0.340	1.025	0.306	0.013	0.058	0.954	−0.156	−0.861	0.390
Constant	9.486	4.122	< 0.001	13.915	9.184	< 0.001	4.474	3.577	< 0.001
R^2		0.036			0.045			0.035	

Relationship Between Gender, Residence, and Information Related to COVID-19

Differences in knowledge related to educational level, gender, residence, income, and age of the respondents were investigated. The statistical outcomes revealed that all variables were non-significant in respect to age and income of the sampled population. Preventive measures to be adopted at t_1 were only significant with respect to gender and residence and at t_2 with respect to education (**Table 6**).

DISCUSSION

The COVID-19 pandemic is one of the most challenging threats to society and public health since World War II, due to its global spread and its effects on almost every aspect of life. The media as social organization may play a vital role because it endorses adaptive measures to promote awareness and knowledge about health-related issues and encourages compliance with precautionary actions (8). The media enjoy widespread rapid access, and, therefore, serves as the major source of information for the general public during the infodemic of COVID-19. An infodemic refers to a rapid and far reaching spread of both accurate and inaccurate information. In this scenario, a global epidemic of misinformation creates severe consequences for public health. Defective and fabricated information could create panic among the masses and affect the

psychological well-being of society. Hence, WHO emphasized the role of media to curb the false information and provide accurate information to people so they are well informed to act appropriately (25).

The COVID-19 epidemic in Wuhan, China, was reported worldwide, including in Pakistan (5, 13). More focused reporting was observed in the media after their global spread, as emphasized by social responsibility theory. The theory of social responsibility states that it is the professional obligation of the media to recognize the needs of the community (26). Pakistani print, electronic, and social media placed more emphasis on the adoption of preventive measures after the first case was reported in Karachi, Sindh, on 26 February 2020. The use of mass media during the initial phases of the event as a quick, effective, and evident mediator was also suggested by Rogers (27). Media outlets in Pakistan are covering the daily COVID-19 statistics. Lockdown in Pakistan led the general public to be concerned about the 2019 Novel Coronavirus (23, 24). The present research investigation evaluated the role of media awareness campaigns in shaping the perceptions of the general population toward COVID-19 in Rawalpindi. The general population utilized different types of media during the COVID-19 pandemic to access information (28). Our investigation shows that the number of users of social and electronic media increased during the coronavirus pandemic, a finding that is reinforced by further international surveys (29, 30). The number of users of print media decreased in the

TABLE 6 | Relationship between gender, residence and information related to COVID-19 ($n = 384$).

Variables	Response	Percentages	χ^2	p-value	Percentages	χ^2	p-value
Gender							
Coronavirus general awareness at t_1					**Coronavirus general awareness at t_2**		
Male	Having knowledge	34.4%	0.00	0.97	43.5%	0.00	0.98
	Not having knowledge	65.6%			56.5%		
Female	Having knowledge	34.2%			43.4%		
	Not having knowledge	65.8%			56.6%		
Symptoms of COVID-19 at t_1					**Symptoms of COVID-19 at t_2**		
Male	Having knowledge	34.4%	0.00	0.97	43.5%	3.47	0.06
	Not having knowledge	65.6%			56.5%		
Female	Having knowledge	34.2%			43.4%		
	Not having knowledge	65.8%			56.6%		
Preventive measures to be adopted at t_1					**Preventive measures to be adopted at t_2**		
Male	Having knowledge	27.6%	4.90	0.04*	53.2%	0.25	0.61
	Not having knowledge	72.4%			46.8%		
Female	Having knowledge	39.5%			50.0%		
	Not having knowledge	60.5%			50.0%		
Residence							
Coronavirus general awareness at t_1					**Coronavirus general awareness at t_2**		
Urban	Having knowledge	37.0%	1.27	0.25	46.0%	1.07	0.30
	Not having knowledge	63.0%			54.0%		
Rural	Having knowledge	31.5%			40.8%		
	Not having knowledge	68.5%			59.2%		
Symptoms of COVID-19 at t_1					**Symptoms of COVID-19 at t_2**		
Urban	Having knowledge	32.0%	1.33	0.24	63.0%	3.34	0.06
	Not having knowledge	68.0%			37.0%		
Rural	Having knowledge	26.6%			53.8%		
	Not having knowledge	73.4%			46.2%		
Preventive measures to be adopted at t_1					**Preventive measures to be adopted at t_2**		
Urban	Having knowledge	35.0%	5.07	0.02*	54.5%	0.60	0.43
	Not having knowledge	65.0%			45.5%		
Rural	Having knowledge	24.5%			50.5%		
	Not having knowledge	75.5%			49.5%		
Education							
Preventive measures to be adopted at t_1					**Preventive measures to be adopted at t_2**		
<11 years	Having knowledge	26.0%	1.91	0.75	36.5%	15.5	<0.01*
	Not having knowledge	74.0%			63.5%		
11-12 years	Having knowledge	33.1%			61.4%		
	Not having knowledge	66.9%			38.6%		
13-14 years	Having knowledge	31.3%			54.2%		
	Not having knowledge	68.8%			45.8%		
15-16 years	Having knowledge	25.0%			50.0%		
	Not having knowledge	75.0%			50.0%		
>16 years	Having knowledge	26.3%			63.2%		
	Not having knowledge	73.7%			36.8%		

*Indicates level of significance at 0.05.

present study between t_1 and t_2. This decrease might be due to fear among users regarding COVID-19 transmission through the newspaper or by the vendor (31). Similar results were reported in India (32).

Pakistan is a male-dominated society; therefore, the majority of participants visiting the research investigation site were male (33), because tasks outside the home are considered to be the responsibility of males. Although gender inequalities have been reported in the education system in Pakistan (34), no significant differences in gender responses were observed in relation to general awareness or knowledge of the symptoms of COVID-19 in either the pre- or the post-response. Education

plays an important role in understanding the medical awareness (35). The finding of low level of information in the present study in any section of the final response may be correlated with the low proportion of high educated respondents as well as the large number of respondents from rural areas. Globally, a growing body of literature reported that there was better health awareness with higher education and urban background (36, 37). Information inequalities may be linked with socioeconomic disparities because almost 90% of the respondents' families were earning <75,000 Pakistani rupees, which is an aspect closely linked with low information levels. An investigation in the United States also showed that low health awareness levels were associated with low socioeconomic status (38).

In Pakistan, many people, especially from rural areas, have the belief that there is no coronavirus and the news items related to COVID-19 are just exaggerations by the media (39). Nearly half of the sampled population in this investigation was from a rural background. The knowledge level was lower in the rural sample than in the urban sample. Although there was an increase in COVID-related knowledge among the rural population after the media awareness campaign in the country, still half of the rural group was ignorant of important aspects. The lack of awareness and misconceptions associated with COVID-19 in the rural populace may be interconnected with low literacy and the prevalence of conspiracy theories (40). Less educated individuals are more likely to believe in false myths (41). The conspiracy theories against COVID-19 are prevalent not only in Pakistan but also in other countries at a global level due to the novelty of the virus (42). Therefore, there is an urgent need that social media and other media networks are engaged in providing accurate information to people so they can act appropriately to save themselves and their next ones from COVID-19.

Overall, the respondents' knowledge related to the coronavirus increased. However, one needs to critically judge whether the anticipated outcomes were achieved solely through effective communication strategies based on the knowledge gap hypothesis (20). Moderate COVID-19 awareness among the general population has been reported in India (43). The level of awareness has been assessed as high among residents of China (44). Our study provides some hints that electronic media in particular may lead to knowledge gains as these are the most commonly used source of information not only for educated and urban people but also for people living in rural areas and with low education (45). However, the ubiquitous presence of COVID-19 in the media makes comparisons between low and high levels of exposure to media campaigns quite challenging. Furthermore, the diffusion of innovation theory also proposes that acceptance takes time and that individual's pass through various phases in the adoption procedure and may acclimatize to the concept during the later phases. Therefore, future investigations may discover improved health awareness among participants related to further items, whereas only limited progress was seen in our study, such as that related to the complications of COVID-19 (26).

The media as a modification agent can affect the behavior of individuals to enable improved well-being by acclimatizing them to the precautionary measures that halt the spread of the virus. Prevention is the essence of public health (46). China successfully controlled the epidemic in Wuhan by applying the preventive approach (47). It is the responsibility of the media to provide timely and correct information for health education and the promotion of prevention strategies. The government, in collaboration with the media, has to address the challenge of information inequalities. Rich clients of the media in Pakistan have access to high-quality and timely information. But information regarding COVID-19 is also the right of people living in rural areas and of vulnerable populations, such as refugees (48). There is a need for guidance to recognize the importance of the media for disseminating information related to the coronavirus. Health journalism requires sound knowledge related to infectious diseases. Lack of knowledge makes it challenging for journalists to describe this public health pandemic.

Limitations

Our study sheds some light on the importance of the media in these times of the coronavirus pandemic. The results are valuable due to the large sample size. The response rate of 100%—without any missing items—indicates that the public is highly aware of the topic. However, the results need to be interpreted with caution because this research does not allow for a classical randomized or experimental study design. We were only able to distinguish between the frequency of use of various media channels. Because of the almost ubiquitous prevalence of information related to COVID-19, one might expect that even a relatively low frequency of media exposure provides information to the public. Furthermore, the results of the linear regression models indicate that there are more variables that were not included (such as health status or interest in health-related issues, and other sources of information like friends, family, healthcare providers etc.), which may further impact upon awareness and knowledge related to COVID-19.

CONCLUSIONS

The results of this study show an overall positive effect in knowledge gains related to COVID-19 as the people acknowledged that they went to media sites for health awareness and their knowledge increased over the 4 weeks' time period. This knowledge gain ultimately encourages the use of healthy behaviors and avoids undesirable deviations in behavior among targeted populations. The investigation also highlighted the choice of media used by the participants. The numbers of social and electronic media users increased significantly during the coronavirus pandemic. It is important to communicate preventive information via the most frequently searched media to enable rapid circulation. Low preventive health awareness was associated with socioeconomically deprived groups. There is a need to develop user-friendly and indigenous communication strategies to improve the knowledge of COVID-19 among masses. Active collaboration between the government and media stakeholders is vital to safeguard the population during the COVID-19 pandemic.

The survey suggested a need for pilot studies utilizing the media during pandemics and epidemics by healthcare stakeholders for the development of rapid and timely information communication strategies. Infodemics related to infectious diseases should be addressed through effective policymaking and implementation. There is a need for inclusion of accurate information on infectious disease reporting based on rational health communication so that infodemics can be avoided in future outbreaks. Governments should address challenges to overcome health communication barriers among different social classes.

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 Institutional Ethical Review Board, University of the Punjab (143/IERB/PU). The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

AR and RZ: conceptualized the study. AR and UH: contributed to data collection. RZ, MZ, KJW, and FF: supported in data analysis. RZ, MZ, and FF: supervised the work and supported in data analysis. AR, RZ, and UH: drafted the manuscript. All authors contributed to revising the manuscript and approved the final manuscript.

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REFERENCES

1. WHO. *2019-nCoV Outbreak is an Emergency of International Concern.* Geneva: World Health Organization (2020). Available online at: http://www.euro.who.int/en/health-topics/health-emergencies/international-health-regulations/news/news/2020/2/2019-ncov-outbreak-is-an-emergency-of-international-concern (accessed September 17, 2021).

2. Zhu Z, Lian X, Su X. Wu, W, Marraro GA, Zeng Y. From SARS and MERS to COVID-19: a brief summary and comparison of severe acute respiratory infections caused by three highly pathogenic human coronaviruses. *Respir Res.* (2020) 21:224. doi: 10.1186/s12931-020-01479-w

3. Jiang S, Du L. Shi, Z. An emerging coronavirus causing pneumonia outbreak in Wuhan, China: calling for developing therapeutic and prophylactic strategies. *Emerg Microbes Infect.* (2020) 9:275–7. doi: 10.1080/22221751.2020.1723441

4. Badshah SL, Ullah A, Badshah SH, Ahmad I. Spread of Novel coronavirus by returning pilgrims from Iran to Pakistan. *J Travel Med.* (2020) 27:taaa044. doi: 10.1093/jtm/taaa044

5. Government of Pakistan. *Know About COVID 19.* Islamabad: Government of Pakistan (2021). Available online at: http://covid.gov.pk/ (accessed September 17, 2021).

6. Khan Y, O'Sullivan T, Brown A, Tracey S, Gibson J, Genereux M, et al. Public health emergency preparedness: a framework to promote resilience. *BMC Public Health.* (2018) 18:1344. doi: 10.1186/s12889-018-6250-7

7. Torani S, Majd PM, Maroufi SS, Dowlati M, Sheikhi RA. The importance of education on disasters and emergencies: a review article. *J Educ Health Promot.* (2019) 8:85. doi: 10.4103/jehp.jehp_262_18

8. Wakefield MA, Loken B, Hornik RC. Use of mass media campaigns to change health behaviour. *Lancet.* (2010) 376:1261–71. doi: 10.1016/S0140-6736(10)60809-4

9. Suresh K. Evidence based communication for health promotion: Indian lessons of last decade. *Indian J Public Health.* (2011) 55:276–85. doi: 10.4103/0019-557X.92405

10. Dali AS. *Health Interventions to Promote the Polio Vaccine Within the Global Polio Eradication Initiative: A Systematic Review from 2000–014.* Atlanta, GA: Georgia State University (2017).

11. Sushil M, Sharma K, Yogesh D, Gupta K, Kumar Y. Mass media for health education: a study in the State of Rajasthan. Multidiscip Int J. (2017). 1:26–39.

12. WHO Regional Office for the Eastern Mediterranean. *WHO Supports Government of Pakistan in Strengthening Novel Coronavirus Preparedness and Response.* (2020). Available online at: http://www.emro.who.int/pak/pakistan-news/who-supports-government-of-pakistan-in-strengthening-novel-coronavirus-preparedness-response.html (accessed September 17, 2021).

13. Government of Pakistan. *National Action Plan for Corona virus Disease (COVID-19) Pakistan.* Islamabad: Government of Pakistan, Ministry of National Health Services, Regulations & Coordination (2021).

14. Jin Y-H, Cai L, Cheng Z-S, et al. A rapid advice guideline for the diagnosis and treatment of 2019 novel coronavirus (2019-nCoV) infected pneumonia (standard version). *Mil Med Res.* (2020) 7:4. doi: 10.1186/s40779-020-0233-6

15. Rastogi M, Pandey N, Shukla A, Singh SK. SARS coronavirus 2: from genome to infectome. *Respir Res.* (2020) 21:318. doi: 10.1186/s12931-020-01581-z

16. Khawar H. Pakistan's vaccination plan for Covid-19. *The Express Tribune.* (2021). Available online at: https://tribune.com.pk/story/2279564/pakistans-vaccination-plan-for-covid-19 (accessed September 17, 2021).

17. Adhikari SP, Meng S, Wu Y-J, Mao Y-P, Ye R-X, Wang Q-Z, et al. Epidemiology, causes, clinical manifestation and diagnosis, prevention and control of coronavirus disease (COVID-19) during the early outbreak period: a scoping review. *Infect Dis Poverty.* (2020) 9:29. doi: 10.1186/s40249-020-00646-x

18. Gao H, Hu R, Yin L, Yuan X, Tang H, Luo L, et al. Knowledge, attitudes and practices of the Chinese public with respect to coronavirus disease (COVID-19): an online cross-sectional survey. *BMC Public Health.* (2020) 20:1816. doi: 10.1186/s12889-020-09961-2

19. Hanan MA, Saleem N, Khawar N, Arshad A. Media and behavior change: effectiveness of public health campaigns in Pakistan. *Isr Med J.* (2019) 11:323–6.

20. Gaziano C. Knowledge gap: history and development. *The International Encyclopedia of Media Effects.* (2017). doi: 10.1002/9781118783764.wbieme0041 (accessed September 17, 2021).

21. Sohaila MT, Mahfoozb Y, Aftabc R, Yend Y, Talibe MA, Rasoolf A. Water quality and health risk of public drinking water sources: a study of filtration plants installed in Rawalpindi and Islamabad, Pakistan. *Desalination Water Treat.* (2020) 181:239–50. doi: 10.5004/dwt.2020.25119

22. The Newspaper's Staff Reporter. Sudden surge in Punjab coronavirus cases after Eid. *Dawn.* (2020). Available online at: https://www.dawn.com/news/1573026 (accessed September 17, 2021).

23. Younus U. Coronavirus hits Pakistan's already-strained economy, and its most vulnerable. *Atlantic Council*. (2020). Available online at: https://www.atlanticcouncil.org/blogs/new-atlanticist/coronavirus-hits-pakistans-already-strained-economy-and-its-most-vulnerable/ (accessed September 17, 2021).

24. Murtaza H. Role of information technology and social media in deadly COVID-19 crisis. *Daily Times*. (2020). Available online at: https://dailytimes.com.pk/589903/role-of-information-technology-and-social-media-in-deadly-covid-19-crisis/ (accessed September 17, 2021).

25. WHO. *Managing the COVID-19 Infodemic: Promoting Healthy Behaviours and Mitigating the Harm from Misinformation and Disinformation*. (2020). Available online at: https://www.who.int/news/item/23-09-2020-managing-the-covid-19-infodemic-promoting-healthy-behaviours-and-mitigating-the-harm-from-misinformation-and-disinformation (accessed September 17, 2021).

26. Institute of Medicine. The future of the public's health in the 21st century. *Committee on Assuring the Health of the Public in the 21st century*. Washington, D.C: National Academies Press (2002).

27. Rogers EM. *Diffusion of Innovations*. New York, NY: Simon and Schuster. (2010).

28. Aslani P. What are our health expectations in a pandemic? *Health Expect*. (2020) 23:257–8. doi: 10.1111/hex.13052

29. Hutchinson A. People are spending 20% more time in apps during the COVID-19 lockdowns. *Social Media Today*. (2020). https://www.socialmediatoday.com/news/people-are-spending-20-more-time-in-apps-during-the-covid-19-lockdowns-re/575403/ (accessed September 17, 2021).

30. Simms J. India's TV and mobile consumption spikes as COVID-19 lockdown progresses. *WARC*. (2020). https://fintechzoom.com/fintech_news_mobile-banking/indias-tv-and-mobile-consumption-spikes-as-covid-19-lockdown-progresses/ (accessed September 17, 2021).

31. Sajjad W. Society: the hawkers without wares. *Dawn*. (2020). Available online at: https://www.dawn.com/news/1590415

32. Dutta AN. Covid-19 hits print media hard—ads and circulation dip, editions see major digital push. *The Print*. (2020). https://theprint.in/india/covid-19-hits-print-media-hard-ads-and-circulation-dip-editions-see-major-digital-push/388514/ (accessed September 17, 2021).

33. Ali TS, Krantz G, Gul R, Asad N, Johansson E, Mogren I. Gender roles and their influence on life prospects for women in urban Karachi, Pakistan: a qualitative study. *Glob Health Action*. (2011) 4:7448. doi: 10.3402/gha.v4i0.7448

34. Chaudhry IS. Gender inequality in education and economic growth: case study of Pakistan. *Pakistan Horizon*. (2007) 60:81–91.

35. Hahn RA, Truman BI. Education Improves Public Health and Promotes Health Equity. *Int J Health Serv*. (2015) 45:657–78. doi: 10.1177/0020731415585986

36. Raghupathi V, Raghupathi W. The influence of education on health: an empirical assessment of OECD countries for the period 1995–2015. *Arch Public Health*. (2020) 78:20. doi: 10.1186/s13690-020-00402-5

37. Aljassim N, Ostini R. Health literacy in rural and urban populations: A systematic review. *Patient Educ Couns*. (2020) 103:2142–54. doi: 10.1016/j.pec.2020.06.007

38. Rikard RV, Thompson MS, McKinney J, Beauchamp A. Examining health literacy disparities in the United States: a third look at the National Assessment of Adult Literacy (NAAL). *BMC Public Health*. (2016) 16:975. doi: 10.1186/s12889-016-3621-9

39. Gillani W. Dangerous theories. *The News International*. (2020). Available online at: https://www.thenews.com.pk/tns/detail/674847-dangerous-theories (accessed September 17, 2021).

40. Frieden J. Lack of Health Literacy a Barrier to Grasping COVID-19. *Medpage Today*. (2020). Available online at: https://www.medpagetoday.com/infectiousdisease/covid19/87002 (accessed September 17, 2021).

41. Seo H, Blomberg M, Altschwager D, Vu HT. Vulnerable populations and misinformation: a mixed-methods approach to underserved older adults' online information assessment. *New Media Soc*. (2020) 23:1461444820925041. doi: 10.1177/1461444820925041

42. Georgiou N, Delfabbro P, Balzan R. COVID-19-related conspiracy beliefs and their relationship with perceived stress and pre-existing conspiracy beliefs. *Pers Individ Dif*. (2020) 166:110201. doi: 10.1016/j.paid.2020.110201

43. Roy D, Tripathy S, Kar SK, Sharma N, Verma SK, Kaushal V. Study of knowledge, attitude, anxiety & perceived mental healthcare need in Indian population during COVID-19 pandemic. *Asian J Psychiatr*. (2020) 51:102083. doi: 10.1016/j.ajp.2020.102083

44. Zhong BL, Luo W, Li HM, Zhang QQ, Liu XG Li WT, Li Y. Knowledge, attitudes, and practices towards COVID-19 among Chinese residents during the rapid rise period of the COVID-19 outbreak: a quick online cross-sectional survey. *Int J Biol Sci*. (2020) 16:1745–52. doi: 10.7150/ijbs.45221

45. Bilal, Latif F, Bashir MF, Komal B, Tan D. Role of electronic media in mitigating the psychological impacts of novel coronavirus (COVID-19). *Psychiatry Res*. (2020) 289:113041. doi: 10.1016/j.psychres.2020.113041

46. Ali A, Katz DL. Disease prevention and health promotion: how integrative medicine fits. *Am J Prev Med*. (2015) 49:S230–40. doi: 10.1016/j.amepre.2015.07.019

47. Tian H, Liu Y, Li Y, Wu C-H, Chen B, Kraemer MUG, et al. An investigation of transmission control measures during the first 50 days of the COVID-19 epidemic in China. *Science*. (2020) 368:638–42. doi: 10.1126/science.abb6105

48. Ifex. Pakistan: The Digital Gap During the COVID-19 Pandemic is Exacerbating Inequalities (2020). Available online at: https://ifex.org/pakistan-the-digital-gap-during-the-covid-19-pandemic-is-exasperating-inequalities (accessed September 17, 2021).

Belonging to Socially Excluded Groups as a Predictor of Vaccine Hesitancy and Rejection

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The scientific call for vaccination against the COVID-19 pandemic has met hesitancy, postponement, and direct opposition of parts of the public in several countries. Mistrusting the COVID-19 vaccine, distrusting the authorities, and unrealistic optimism, are three major reasons employed in justifying vaccine hesitancy. The present study examines two major issues. First, it strives to identify individuals that are unwilling to adhere to the vaccination process, more strongly question the effectiveness and necessity of the COVID-19 vaccine, and wonder about potential covert reasons for its administration. Second, it investigates associations between such "conspiracy" claims and the actual rejection of the vaccine. We assume that individuals belonging to social groups which are partly excluded by the general society will be less willing to fulfill the demands of this society, more inclined to reject the vaccine and associate it with some hidden conspiracy. A relatively large sample of the Israeli public ($N = 2002$) has responded to an anonymous questionnaire pertaining, among other things, to vaccine hesitancy and the individual level of vaccine uptake. Previous research has mainly examined the reasons for vaccine hesitancy. The present study's results indicate that three out of four social exclusion criteria (young adulthood, low level of income, and orthodox religiosity) have negatively predicted vaccine uptake and positively predicted three types of reasoning for vaccine hesitancy. Young adulthood was the strongest predictor of vaccine rejection. Attempts at convincing hesitating individuals to uptake this vaccine have often failed in many countries. As varied reasons underlie vaccine refusal, it is suggested that the approach to different vaccine rejecting groups should not be generic but rather tailor-made, in an attempt to influence their perceptions and behavior.

Keywords: vaccine hesitancy, vaccine rejection, conspiracy theories, partially excluded social groups, COVID-19

INTRODUCTION

The COVID-19 pandemic has caught countries worldwide unprepared for coping with this plague and without a supply of an effective vaccine. Vaccines are considered one of the most successful public health interventions of the 20th century for containing infectious diseases (1). Recent data show that most of the inhabitants of Europe (2), North American (3, 4), and South American

countries (5) are willing to be vaccinated against this pandemic. The majority of the Israeli population has already been inoculated, at least once, against the COVID-19 virus (6). However, despite the substantial risk of this pandemic, a substantial number of individuals all over the world express vaccine hesitancy and vaccine rejection. It should be noted that vaccine hesitancy is not a specific characteristic of the COVID-19 endemic. It is as old as the vaccine itself, and was also observed in previous pandemics [e.g., (7–10)].

Previous Israeli studies have found differences in vaccine hesitancy among health professionals (11, 12). The present study examines hesitancy in the general Israeli public and examines two major subjects. The major issue, which has hardly been examined empirically, refers to the impact of belonging to a socially excluded or partly excluded group, on vaccine rejection. In terms of Israel, "vaccine rejection" refers to one's status concerning the full vaccination process, which is required of Israeli citizens (i.e., to date, two vaccines and a booster). The second concern is vaccine hesitancy, which is expressed by questioning the necessity and effectiveness of this vaccine. These doubts frequently involve suspicions, leading to the perception that administering it to the public is associated with some kind of conspiracy.

A recent worldwide study explains COVID-19 vaccination hesitancy by mistrust in several key actors, including scientists, domestic healthcare professionals, and politicians (13). Additional research claims that this vaccine hesitancy often reflects conspiracy beliefs (14). These ideas have flourished with the COVID-19 pandemic, due to the spectacular rate of medical misinformation (15), and a growing readiness to accept statements from sources that question the legitimacy of the political system (16, 17). Conspiracy theories have been defined as "attempts to explain the ultimate causes of significant social and political events and circumstances, with claims of secret plots by two or more powerful actors" [(18), p. 4]. Heightened collective uncertainty and fear characteristics of social crises might enhance attempts to explain this threatening, complex and unpredictable situations, in terms of conspiracy beliefs (19, 20). Freeman and Bentall (21) claim that although false conspiracy theories are not supported by evidence, those who hold them believe that the present crisis is falsely presented by some unknown power, which presents the public with a cover-up narrative of the actual situation.

Attempts to understand the identity of those who regard vaccinations as involving a conspiracy of some unknown power, claim that less educated people hold these beliefs more often (22) and that individuals of lower-income and education, as well as those who regard themselves as politically powerless, are more susceptible to conspiracy theorizing about the origins and severity of the current pandemic (23). An additional review of 97 articles confirms that women, young adults, low education, and low-income individuals, as well as extremely religious and non-liberal people, are more prone to vaccine hesitancy (24). An Australian study (25) adds that living in disadvantaged areas and holding more populist views are associated as well with higher vaccine hesitancy.

In addition to the above already established findings concerning characteristics of vaccine hesitancy and vaccine

dissenters, we suggest that in case of an epidemic, people who belong to social groups which are partly excluded and perhaps less appreciated, as well as those who deliberately choose to isolate themselves from this society, are more likely to believe in conspiracy claims. Furthermore, they are more likely to reject the vaccine aimed at coping with this plague. However, there is hardly any empirical data concerning the impact of being part of such a group on the decision of whether or not to be vaccinated.

In line with Douglas' (26) analysis of the functions of conspiracy and the identified characteristics of those who hold conspiracy ideas more readily (13), we assume that in many cases the conspiracy beliefs expressed in cases of vaccine hesitancy and rejection may have a distinct social function. These responses can constitute channels of the objection, employed by individuals who feel that they are either partly excluded from the general society, or are not well-assimilated within it.

The European Commission (27) has pointed out the objective risk factors, which may exert a negative influence on the prospect of social inclusion: low income, unskilled labor, poor health, low education level, school dropout, inequality, immigration, discrimination, and racism, old age, divorce, and living in a "problem accumulation area." Rather than defining marginalization in such generality, we claim that belonging to a socially excluded, or partly excluded group constitutes a subjective lens through which people look at reality. In contrast, taking part in social interactions and feelings included helps people sustain their psychological well-being (28). Hence, those who feel socially excluded are likely to suffer aversive psychological consequences (29, 30). Theoretical analyses claim that relational evaluation is a key mechanism in understanding the degree to which such exclusion causes negative psychological outcomes, and promotes behaviors aimed at safeguarding this evaluation (31, 32).

We believe that in terms of the Jewish population of Israel, the individual sense of being segregated may be associated with belonging to the four following groups. Lower-income and lower education levels are two attributes that may make people feel that their chances of improving their living conditions are rather scarce and that they are already partly excluded by the general society (33). There is growing evidence that income inequality is associated with mental health outcomes and may cause status anxiety, clinical depression as well as a low self-perception (34). Ultra-orthodox religiosity, which promotes the disagreement on the issue of what Jewish identity is mainly about, constitutes a third potential exclusion reason. The orthodox perspective is that being Jewish is mainly a matter of religion, while the majority of secular Jews tend to regard Judaism mainly as a matter of ancestry and culture (35). Ultra-orthodox individuals wish, therefore, to exclude themselves from the secular way of life of the general society, and live as a separate social entity most likely in segregated and closed communities. Young adulthood may constitute a fourth reason for feeling exclusion. Young adults who are well aware of the fact that they have not as yet become a part of the grownup society, are likely to wonder how their lives will look like in the future, and whether they will succeed in establishing a desired social or professional position when they will grow (23). There is no clear definition for the developmental

stage of young adulthood, but since its developmental tasks are attained at different stages, the consolidation of adult status is likely to be achieved closer to the end of the third decade of life (36). In line with this analysis, young adulthood is determined, in the present study, by the 20–39 years' age range.

The Israeli government currently demands all inhabitants to show good citizenship and social responsibility to fellow Israelis, by being vaccinated against the COVID-19 pandemic. We assume that individuals who belong to partly excluded social groups, as were presented in the above paragraphs, are more likely to express criticism of the integrity and the intentions of the authorities, as well as the pharmaceutical companies, and to feel that some conspiracy underlies the vaccination request. Furthermore, we expect them to respond negatively to this governmental request to complete their vaccination process.

The present study examines three modes of conspiracy claims in response to the vaccination request. First, suspect the authorities (37). Research has shown that conspiracy theories are likely to channel people's feelings of resentment toward political targets and to support radical attitudes (38). Second, questioning the integrity of the pharmaceutical companies: a general feeling of missing relevant information concerning the vaccine's effectiveness (39, 40), and concerns about unforeseen side effects and risks of this vaccine (2, 5). A third, indirect claim of conspiracy, which is phrased in terms of unrealistic optimism, argues that the risk of this plague, as presented by the authorities, is highly exaggerated and unjustified (41). Unrealistic optimism is a much wider concept which is defined as the "tendency for people to believe that they are less likely to experience negative events and more likely to experience positive events than are other people" [(42), p. 65]. In the present case, unrealistic optimists regard the threat of this pandemic as irrelevant to themselves, believing that they are more resilient than most people (43), and are less likely to experience negative events in general and to be infected by the COVID-19 virus, in particular.

Two hypotheses were examined:

a. Younger age, lower education level, lower income, and a higher level of orthodox religiosity will negatively predict individual vaccine uptake and will positively predict the three modes of conspiracy claims (distrust in the authorities, distrust in the vaccine, and unrealistic optimism).
b. Direct, as well as indirect, conspiracy claims concerning the COVID-19 vaccination will be positively correlated with each other, and will negatively correlate with individual vaccine uptake.

METHODS

Data Collection

Individuals from all over Israel ($N = 2002$) have responded between October 8-12 2021 to an online questionnaire, distributed by an Internet Panel company that has a database of more than 65,000 panelists, representing the varied demographic groups in Israel (https://sekernet.co.il/). The respondents that are registered were approached directly by the company, without any disclosure of their identity to the researchers. To enable a representative sample, a stratified sampling method was employed, aligned with the data published by the Israeli Central Bureau of Statistics regarding geographic distribution, gender, and age. The study was approved by the Ethics Committee of the Tel Aviv University, #0003903-1 from September 30, 2021.

Participants

Participants are 2002 individuals representing all parts of the Israeli Jewish population. **Table 1** presents their demographic variables shows that their ages range from 18 to 82 years, 51% of them are females and 49% are males. They represent wide ranges of religiosity, income levels, political attitudes, and years of education. 68% of them have been vaccinated three times as requested.

Measures

Level of Vaccine Uptake

Israeli residents were requested, to date, to be vaccinated three times against COVID-19 (the third vaccine is a booster). The degree of vaccine uptake was determined by a single item: "To what extent are you currently vaccinated against the COVID-19?" The four-point response scale ranges from 1 = not vaccinated, to 4 = Vaccinated three times.

Concerns About Potential Conspiracies

This scale which has been devised for the present study includes three sub-scales. The first (eight items, Cronbach's $\alpha = 0.885$) refers to a disbelief in the COVID-19 vaccine (examples: "There is not enough scientific support for the effectiveness of this vaccine"; "The COVID-19 vaccine prevents the human body from developing its natural antibodies"). The second sub-scale (three items, $\alpha = 0.730$) pertains to disbelief in the authorities (examples: "The COVID-19 vaccine represents a conspiracy of the authorities"; "The COVID-19 vaccine is aimed at controlling and supervising people"). The third scale (four items, $\alpha = 0.872$) pertains to unrealistic optimism (examples: "The doctors' warnings on the risk of the COVID-19 pandemic are exaggerated"; "I cope with health issues better than other people, therefore, I don't need this vaccine"). The 5-point response scale ranged from 1 = Do not agree at all, to 5 = Agree very much.

The five investigated demographic attributes were defined as follows:

Young adulthood. Respondents indicated their age in years.
Religiosity was determined by the question "How would you define your level of religiosity?" The four response options were: 1. Secular, 2. Traditional, 3. Religious, 4. Ultra-orthodox.
Income level was established by the following item: "The average income of an Israeli family today is 18,671 NIS per month. Your family's income is 1. Much lower than this average, 2. Lower than this average, 3. About this average, 4. Higher than this average, 5. Much higher than this average."
Political attitudes were determined by the following item: "How would you define yourself politically as far as foreign affairs and security policies are concerned?" The five response options were: 1. Extreme left, 2. Left, 3. Center, 4. Right, 5. Extreme right.

TABLE 1 | Demographic characteristics of the participants.

Variable	Group	Student sample		
		Number	%	M (SD)
Age	18–30	581	29	42.18 (15.64)
	40–31	441	22	
	50–41	366	18	
	51–60	298	15	
	61–82	316	16	
Gender	Men	985	49	
	Women	1,017	51	
Religiosity	Secular	927	46	1.84 (0.95)
	Traditional	640	32	
	Religious	266	13	
	Very religious	169	9	
Political attitudes	Extreme left	35	2	3.49 (0.89)
	Left	220	11	
	Center	706	35	
	Right	816	41	
	Extreme right	225	11	
Family income compared to average in Israel	Much below	532	27	
	Below	441	22	
	Average	597	30	
	Above	325	16	
	Much above	107	5	
Education	1. Elementary	31	2	3.33 (1.06)
	2. High school	488	24	
	3. Higher education	583	29	
	4. B.A.	580	29	
	5. M.A. and above	320	16	
Nationality	Jewish	1,880	94	
	Other	122	6	
Family status	Bachelor	541	27	
	Married	1,158	58	
	Divorce	169	8	
	Widower	27	1	
	In a relationship	107	5	
Vaccine status	1. Three vaccines	1,367	68	
	2. Two vaccines	315	16	
	3. One vaccine	98	5	
	4. No vaccine	222	11	

The level of education was determined by the item "What is your education level?" The five response options were: 1. Primary education, 2. Secondary education, 3. Higher than secondary education (vocational), 4. Bachelor's degree, 5. Masters' degree or higher.

Statistical Analysis

The hypotheses were examined by means of a path analysis/Amos Structural Equation Modeling, in which the four predictors and the four predicted variables were controlled for each other [IBM, SPSS, https://www.ibm.com/il-en/marketplace/structural-

FIGURE 1 | Standardized estimates of path analyses of demographic characteristics predicting vaccine hesitancy and uptake. Thin paths are insignificant. Thick path $p < 0.01$.
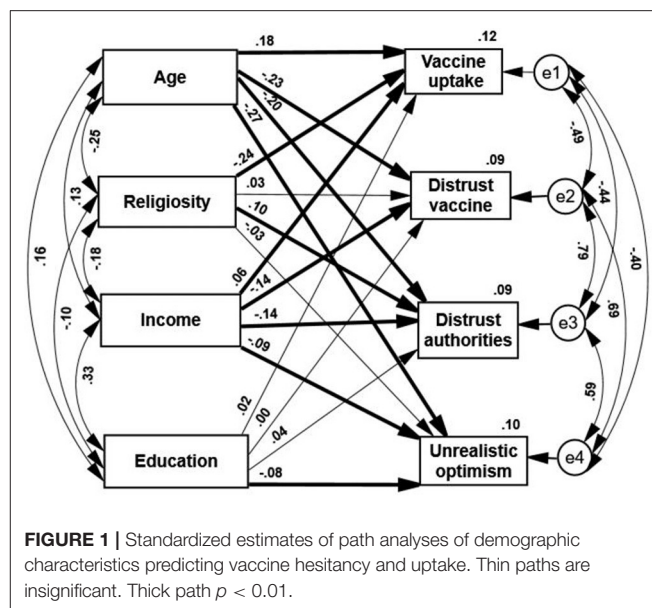
equation-modeling-sem; (44)]. Maximum likelihood estimates were employed and examined a saturated model, as we did not find any studies that supported an alternative model. It is important to note that in a saturated model, there is no need to examine a model fit as the default and the saturated model are the same (45). This saturated model (all paths are examined), which examined this hypothesis, included the four demographic attributes as the predictors; the three conspiracy expressions and the level of vaccination were the predicted variables. The variability in vaccine uptake according to demographic characteristics of vaccinated vs. none-vaccinated individuals was examined using t-test. All statistical analyses were performed using IBM SPSS and AMOS software version 26. P-values lower than 0.05 were considered as statistically significant.

RESULTS

Hypothesis A claimed that younger age, lower levels of education and income, as well as more orthodox religiosity will negatively predict vaccine uptake and will positively predict each of the three conspiracy expressions.

The path analysis indicated the following (**Figure 1**): (a) Age of the respondents was positively correlated with levels of education and income and negatively correlated with orthodox religiosity. This religiosity was negatively correlated with the level of income and with formal education. Income is positively correlated with the level of education.

(b) Three out of the four demographic attributes negatively predicted the vaccination status. Higher vaccine uptake was positively predicted by older age and higher income and negatively predicted by orthodox religiosity. It was not significantly predicted by the level of education. These results generally supported the first part of the first hypothesis.

TABLE 2 | *T*-tests comparing the demographic characteristics of individuals vaccinated three times vs. none-vaccinated individuals.

		Not vaccinated $N = 222$	Vaccinated $N = 1,367$	t	Sig. (2-tailed)	Effect size Cohen's d
Education	Mean	3.01	3.43	−5.810	0.000	0.40
	SD	0.989	1.068			
Gender	Mean	1.51	1.50	0.198	0.843	0.01
	SD	0.501	0.500			
Age	Mean	34.68	45.69	−12.050	0.000	0.78
	SD	12.027	15.823			
Religiosity	Mean	2.25	1.67	7.761	0.000	0.60
	SD	1.058	0.848			
Income	Mean	2.14	2.66	−6.090	0.000	0.46
	SD	1.164	1.197			

(c) In line with the second part of this hypothesis, younger age and lower income positively and significantly predicted each of the three claims of covert intentions (distrusting the vaccine, mistrusting the authorities, and unrealistic optimism). Higher claims of mistrust were made by younger and low-income respondents. A lower level of education negatively and significantly predicted unrealistic optimism, and a higher level of religiosity positively predicted distrust in the authorities.

(d) Despite the differences among the three modes of vaccine rejection, they correlated positively with each other, indicating that all of them were likely connected to a more general source of conspiracy claims. In addition, all these three claims correlate negatively and significantly with vaccine uptake, thus can be viewed as attitudes that lead to action. Those who expressed a higher sense of conspiracy failed to complete their vaccination process to a greater extent.

A further examination of the variability of level of vaccination according to the demographic characteristics was done by computing *T*-tests which compared these attributes of the individuals who have been vaccinated three times, with those who did not vaccinate at all. **Table 2**, presenting these comparisons, shows that the vaccinated group surpasses the none-vaccinated group significantly on levels of education (medium effect size), age (large effect size) and income (medium effect size). The vaccinated group scores lower on level of religiosity (large effect size). No gender differences were found between the two groups. These findings constitute additional support for the path analysis results.

DISCUSSION

The present study examined the impact of belonging to a partly excluded social group on the level of vaccine uptake, and its association with perceived "conspiracy" theories. The study was conducted during October 2021, a period characterized by an ongoing decrease in levels of COVID-19 infectivity, and an increase in levels of vaccinations. The request for the COVID-19 vaccination raised strong public claims of some

hidden conspiracies which were directed at the pharmaceutical companies and the political authorities. Previous research linked conspiracy beliefs with vaccination hesitancy (46) suggesting that conspiracy beliefs may undermine the motivation to take action in case of a pandemic (47). The World Health Organization (48) claimed that vaccine hesitancy was increased by the following causes: (1) people's belief that they are at low risk of contracting COVID-19, or that the consequences of becoming infected will not be severe; (2) people's lack of confidence in the vaccines' effectiveness and specific beliefs that the COVID-19 vaccine was rushed and not tested thoroughly; (3) the trust in the vaccine efficiency was undermined by the regulation to wear masks and to maintain social distancing despite being vaccinated; and, (4) skepticism about covert profit motives of pharmaceutical companies. Furthermore, people were inevitably exposed to misinformation, rumors, and a variety of false conspiracy theories, which could have eroded their confidence in the vaccine specifically and the vaccination program, in general.

The WHO (48) criteria for vaccine hesitancy referred to the general public. Several studies pointed at demographic characteristics which were associated with vaccine hesitancy and conspiracy ideas [e.g., (22, 23)]. These studies did not associate vaccine rejection with belonging to groups that were partly excluded from the general society, nor did they claim that these conspiracy ideas would be endorsed more readily by individuals who were part of such groups (49, 50). The present study clearly shows that belonging to any of the partly excluded young adults, low income, low education, or higher religiously orthodox groups, negatively impacted the vaccine uptake. Young adults, who may wonder whether they will succeed in establishing their desired social position in the future (23), are not generally considered as individuals whose place in society is still undetermined. They are not regarded as partly marginal like the low income group. However, it cannot be argued that young adults may be hesitant to get vaccinated against the COVID-19 due to relatively lower risks to their health, compared with older adults. This appears to be the case, despite the fact that the Israeli Ministry of Health (51) indicated contrarily, that the Israeli

young adult age group (aged 20–39) has suffered a higher percentage of Coronavirus infections compared to the other age groups.

Previous research assumed that those who postponed being vaccinated would eventually reject this vaccine altogether [e.g., (14)]. The present data showed that vaccine hesitancy and questioning the effectiveness and necessity of the vaccine were indeed negatively correlated with vaccine uptake. We are not aware of a prior study that has demonstrated empirically a direct impact of being a part of such excluded social groups, on actual vaccine rejection. Our data showed further that belonging to one of these groups predicted higher rates of the three conspiracy claims as well, although less consistently.

The present study indicated that individual vaccine status, i.e., the actual level of vaccine uptake (out of the three required injections), was significantly predicted by belonging to a partly excluded social group and that being a young adult impacted most strongly vaccine rejection and hesitancy: the younger the age, the greater the hesitancy and rejection of this vaccine. What characterizes members of this group? Young adulthood requires the adoption of new roles and statuses and achievement of success in several domains concurrently: leaving the parental home to establish one's residence, gaining financial independence, completing school, progressing into full-time employment, getting married, and becoming a parent (52, 53). These actions emphasize the fragility of the process of personal development which is tested anew during young adulthood (54). The constant awareness of young adults of the assignments which lay ahead of them, and the vital importance of succeeding in them, constantly emphasize their sense of not being assimilated yet in the adult society (55–57). Furthermore, the present results indicate that two of the investigated demographic characteristics, constitute the best predictors of both vaccination uptake and hesitancy: young adulthood and the lower income.

LIMITATIONS

The major limitation of this study is common to all studies which employ the self-report technique. We assume that the information provided by the participants is both sincere and exact since they are defended by anonymity. However, there is no way to test this assumption. Second, we have used short forms of the scales that were previously employed. Although these short scales have retained their high reliabilities, employing the full scales is still recommended. A third limitation is that the present study examines vaccination hesitancy and refusal only among Israeli Jews, who may feel excluded in part from the general society. Further research should investigate as well Israeli Arabs, who constitute a large Israeli minority, which is likely to feel partly excluded by the general public (58).

CONCLUSION

One study of the public's attitudes toward the COVID-19 virus vaccine recommends creating an environment that will make the vaccine more available and increase social influence by using the recommendations of particularly trusted experts. The assumption is that these experts would increase the public's motivation and compliance by dialogues about the safety and benefits of this vaccine, as compared to the risks and uncertainty associated with it (48). Another analysis regards the belief in COVID-related conspiracy theories as to the source of the resistance to both preventive behaviors and future vaccines for this virus. It recommends a confrontation of both conspiracy theories and vaccination misinformation, to prevent further spread of the virus by politically conservative American outlets that have supported COVID-related conspiracy theories (23). The present study demonstrated empirically that belonging to a partly excluded social group negatively affected the COVID-19 vaccination. We believe, therefore, that in such cases of vaccine rejection more efficient approach would be to fit a tailor-made message to each specific group independently. Members of these groups could be encouraged to uptake the vaccine provided that they will be approached by trusted and respected group leaders with whom they may identify and whose messages they can accept. Each group should be approached differently. More sophisticated individuals would appreciate a presentation of the pros and cons concerning this vaccine, whereas other groups are more likely to prefer clear-cut information presented by an authority figure. Thus, for instance, there is reason to believe that more orthodox religious people will listen more readily to an orthodox religious authority figure, rather than to public health officials. Future studies should investigate the contribution of individual sense of social exclusion to vaccine rejection and the psychological means employed by members of socially excluded groups, that impact their adherence or rejection of the request to be vaccinated against COVID-19.

DATA AVAILABILITY STATEMENT

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

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Ethics Committee of the Tel Aviv University. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

REFERENCES

1. Centers for Disease Control and Prevention (CDC). Ten great public health achievements the United States, 1900-1999. *MMWR Morb Mortal Wkly Rep.* (1999) 48:241–3. Available online at: https://www.cdc.gov/mmwr/preview/mmwrhtml/00056796.htm (accessed November 20, 2021).

2. Paul E, E., Steptoe AS, Fancourt D. Attitudes towards vaccines and intention to vaccinate against COVID-19: implications for public health communications. *Lancet Reg Health Eur.* (2021) 1:100012. doi: 10.1016/j.lanepe.2020.100012

3. Dzieciolowska S, Hamel D, Gadio S, Dionne M, Gagnon D, Robitaille L, et al. Covid-19 vaccine acceptance, hesitancy, and refusal among Canadian healthcare workers: a multicenter survey. *Am J Infect Control.* (2021) 49:1152–7. doi: 10.1016/j.ajic.2021.04.079

4. Muhajarine N, Adeyinka DA, McCutcheon J, Green KL, Fahlman M, Kallio N. COVID-19 vaccine hesitancy and refusal and associated factors in an adult population in Saskatchewan, Canada: evidence from predictive modeling. *PloS one.* (2021) 16:e0259513. doi: 10.1101/2021.06.28.21259675

5. Cerda AA, García LY. Hesitation and refusal factors in individuals' decision-making processes regarding a Coronavirus disease 2019 vaccination. *Front Public Health.* (2021) 9:626852. doi: 10.3389/fpubh.2021.626852

6. Rosen B, Waitzberg R, Israeli A. Israel's rapid rollout of vaccinations for COVID-19. *Isr J Health Policy Res.* (2021) 10:6. doi: 10.1186/s13584-021-00440-6

7. Callender D. Vaccine hesitancy: more than a movement. *Hum Vac Immunother.* (2016) 12:2464–8. doi: 10.1080/21645515.2016.1178434

8. Keenan A, Ghebrehewet S, Vivancos R, Seddon D, MacPherson P, Hungerford D., et al. Measles outbreaks in the UK, is it when and where, rather than if? a database cohort study of childhood population susceptibility in Liverpool, U*K. BMJ Open.* (2017) 7:e014106. doi: 10.1136/bmjopen-2016-014106

9. Larson HJ. The state of vaccine confidence. *Lance*t. (2018) 392:2244–6. doi: 10.1016/S0140-6736(18)32608-4

10. Turner R. Measles vaccination: a matter of confidence and commitment. *PLoS Med.* (2019) 16:e1002770. doi: 10.1371/journal.pmed.1002770

11. Dror AA, Eisenbach N, Taiber S, Morozov NG, Mizrachi M, Zigron A, et al. Vaccine hesitancy: the next challenge in the fight against COVID-19. *Eur J Epidemiol.* (2020) 35:775–9. doi: 10.1007/s10654-020-00671-y

12. Shacham M, Greenblatt-Kimron L, Hamama-Raz Y, Martin LR, Peleg O, Ben-Ezra M, et al. Increased COVID-19 vaccination hesitancy and health awareness amid COVID-19 vaccinations programs in Israel. *Int J Environ Res Public Health.* (2021) 18:3804. doi: 10.3390/ijerph18073804

13. Rozek LS, Jones P, Menon A, Hicken A, Apsley S, King EJ. Understanding vaccine hesitancy in the context of COVID-19: the role of trust and confidence in a seventeen-country survey. *Int J Public Health.* (2021) 66:636255. doi: 10.3389/ijph.2021.636255

14. Bertin P, Nera K, Delouvée S. Conspiracy beliefs, rejection of vaccination, and support for hydroxychloroquine: a conceptual replication-extension in the COVID-19 pandemic context. *Front Psychol.* (2020) 11:565128. doi: 10.31234/osf.io/rz78k

15. Kouzy R, Abi Jaoude J, Kraitem A, El Alam MB, Karam B, Adib E, et al. Coronavirus goes viral: Quantifying the COVID-19 misinformation epidemic on twitter. *Cureus J Med Sci.* (2020) 12:e7255. doi: 10.7759/cureus.7255

16. Hahl O, Kim M, Zuckerman EW. The authentic appeal of the lying demagogue: proclaiming the deeper truth about political illegitimacy. *Am Sociol Rev.* (2018) 83:1–33. doi: 10.1177/0003122417749632

17. Harambam J, Aupers S. Contesting epistemic authority: conspiracy theories on the boundaries of science. *Publ Underst Sci.* (2015) 24:466–80. doi: 10.1177/0963662514559891

18. Douglas KM, Uscinski JE, Sutton RM, Cichocka A, Nefes T, Ang CS, et al. Understanding conspiracy theories. *Polit Psychol.* (2019) 40:3–35. doi: 10.1111/pops.12568

19. Franks B, Bangerter A, Bauer M. Conspiracy theories as quasi-religious mentality: an integrated account from cognitive science, social representations theory, and frame theory. *Front Psychol.* (2013) 4:424. doi: 10.3389/fpsyg.2013.00424

20. van Prooijen JW, Douglas KM. Belief in conspiracy theories: basic principles of an emerging research domain. *Eur J Soc Psychol.* (2018) 48:897–908. doi: 10.1002/ejsp.2530

21. Freeman D, Bentall R. The concomitants of conspiracy concerns. *Soc Psychiatry Psychiatr Epidemiol.* (2017) 52:595–604. doi: 10.1007/s00127-017-1354-4

22. van Prooijen JW. Why education predicts decreased belief in conspiracy theories, *Appl Cogn Psychol.* (2017) 31:50–8. doi: 10.1002/acp.3301

23. Romer D, Jamieson KH. Conspiracy theories as barriers to controlling the spread of COVID-19 in the U.S. *Soc Sci Med.* (2020) 263:113356. doi: 10.1016/j.socscimed.2020.113356

24. Aw J, Seng JJB, Seah SSY, Low LL. COVID-19 vaccine hesitancy-a scoping review of literature in high-income countries. *Vaccines (Basel).* (2021) 9:900. doi: 10.3390/vaccines9080900

25. Edwards B, Biddle N, Gray M, Sollis K. COVID-19 vaccine hesitancy and resistance: Correlates in a nationally representative longitudinal survey of the Australian population. *PLoS ONE.* (2021) 16:e0248892. doi: 10.1101/2020.11.13.20231480

26. Douglas KM. COVID-19 conspiracy theories. *Group Process Intergr Relat.* (2021) 24:270–5. doi: 10.1177/1368430220982068

27. European Commission. *Joint Report on Social Inclusion 2001.* Luxembourg: Office for Official Publications of the European Communities (2002).

28. Baumeister RF, Leary MR. The need to belong: desire for interpersonal attachments as a fundamental human motivation. *Psychol Bull.* (1995) 117:497–529. doi: 10.1037/0033-2909.117.3.497

29. Leary MR. Making sense of self-esteem. *Curr Dir Psychol Sci.* (1999) 8:32–5. doi: 10.1111/1467-8721.00008

30. Williams KD. Ostracism: effects of being excluded ignored. In Zanna M, editor. *Advances in Experimental Social Psychology.* New York, NY: Academic Press (2009). pp. 275–314.

31. Leary MR. Responses to social exclusion: social anxiety, jealousy, loneliness, depression, and low self-esteem. *J Soc Clin Psychol.* (1990) 9:221–9. doi: 10.1521/jscp.1990.9.2.221

32. Wesselmann ED, Wirth JH, Pryor JB, Reeder GD, Williams KD. When do we ostracize? *Soc Psychol Pers Sci.* (2013) 4:108–15. doi: 10.1177/1948550612443386

33. Weyers S, Dragano N, Möbus S, Beck EM, Stang A, Möhlenkamp S, et al. Low socio-economic position is associated with poor social networks and social support: results from the Heinz Nixdorf Recall Study. *Int J Equity Health.* (2008) 7:13. doi: 10.1186/1475-9276-7-13

34. Heinz A, Zhao X, Liu S. Implications of the association of social exclusion with mental health. *JAMA Psychiatry.* (2020) 77:113–4. doi: 10.1001/jamapsychiatry.2019.3009

35. Pew Research Center Report. *Israel's Religiously Divided Society.* Washington, DC: Pew Research Center (2016).

36. Shulman S, Ben-Artzi E. Age-related differences in the transition from adolescence to adulthood and links with family relationships. *J Adult Dev.* (2003) 10:217–26. doi: 10.1023/A:1026006025155

37. El-Elimat T, Abu Al Samen MM, Basima A, Almomani BA, et al. Acceptance and attitudes toward COVID-19 vaccines: a cross-sectional study from Jordan. *PLoS ONE.* (2021) 16:e0250555. doi: 10.1101/2020.12.22.20248676

38. Vegetti F, Littvay L. Belief in conspiracy theories and attitudes toward political violence. *Italian Political Science Review/Rivista Italiana Di Scienza Politica.* (2021) 1–15. doi: 10.1017/ipo.2021.17

39. Petersen MB, Bor A, Jørgensen F, and Lindholt MF. Transparent communication about negative features of COVID-19 vaccines decreases acceptance but increases trust. *PNAS.* (2021) 118:e2024597118. doi: 10.1073/pnas.2024597118

40. Neumann-Böhme S, Varghese NE, Sabat I, Barros PP, Brouwer W, van Exel J, et al. Once we have it, will we use it? a European survey on willingness to be vaccinated against COVID-19. *Eur J Health Econ.* (2020) 21:977–82. doi: 10.1007/s10198-020-01208-6

41. Kirscht JP, Haefner DP, Kegeles FS, Rosenstock IM. A national study of health beliefs. *J Health Hum Behav.* (1966) 7:248–54. doi: 10.2307/2948771

42. Shepperd JA, Carroll P, Grace J, Terry M. Exploring the causes of comparative optimism. *Psychol Belg.* (2002) 42:65–98. doi: 10.5334/pb.986

43. Brown JD. Understanding the better than the average effect: motives (still) matter. *Pers Soc Psychol Bull.* (2012) 38:209–19. doi: 10.1177/0146167211432763

44. Arbuckle JL. *Amos 20 User's Guide.* Chicago, IL: SPSS Inc. (2011).

45. Arbuckle J, Wothke W. *Structural Equation Modeling Using AMOS: An Introduction*. Chicago, IL: Small Waters (2004).

46. Hornsey MJ, Finlayson M, Chatwood G, Begeny CT. Donald Trump and vaccination: the effect of political identity, conspiracist ideation and presidential tweets on vaccine hesitancy. *J Exp Soc Psychol*. (2020) 88:103947. doi: 10.1016/j.jesp.2019.103947

47. Uscinski JE, Klofstad C, and Atkinson MD. What drives conspiratorial beliefs? the role of informational cues and predispositions. *Polit Res Q*. (2016) 69:57–71. doi: 10.1177/1065912915621621

48. World Health Organization (WHO). *Behavioral considerations for acceptance and uptake of COVID-19 vaccines: WHO Technical Advisory Group on Behavioural Insights and Sciences for Health, Meeting Report, 15 October 2020*. Geneva: World Health Organization (WHO) (2020).

49. Halperin E, Bar-Tal D, Nets-Zehngut R, Drori E. Emotions in conflict: Correlates of fear and hope in the Israeli-Jewish society. *Peace Conflict*. (2008) 14:233–58. doi: 10.1080/10781910802229157

50. Jarymowicz M, Bar-Tal D. The dominance of fear over hope in the life of individuals and collectives. *Eur J Soc Psychol*. (2006) 36:367–92. doi: 10.1002/ejsp.302

51. Hanukoglu, Israel. *Coronavirus COVID-19: Age distribution of confirmed cases in Israel*. (2021). Available online at: https://www.science.co.il/medical/covid-19/Distribution-age.php (accessed November 24, 2021).

52. Macmillan R, Eliason SR. Characterizing the life course as role configurations pathways: a latent structure approach. In Mortimer JT, Shanahan MJ, editors, *Handbook of the Life Course*. New York, NY: Kluwer Academic/Plenum (2003). pp. 529–54.

53. Shanahan MJ. Pathways to adulthood in changing societies: variability and mechanisms in life course perspective. *Annu Rev Sociol*. (2000) 26:667–92. doi: 10.1146/annurev.soc.26.1.667

54. Scales PC, Benson PL, Oesterle S, Hill KG, Hawkins JD, Pashak TJ. The dimensions of successful young adult development: A conceptual and measurement framework. *Appl Dev Sci*. (2015) 20:150–74. doi: 10.1080/10888691.2015.1082429

55. Kimhi S, Eshel Y, Marciano H, Adini B, Fluctuations in National resilience along the, C. O. V. I. D.-19–a longitudinal study. *Int J Environ Res Public Health*. (2021) 18:3876. doi: 10.3390/ijerph18083876

56. Prime H, Wade M, Browne DT. Risk and resilience in family well-being during the COVID-19 pandemic. *Am Psychol*. (2020) 75:631–43. doi: 10.1037/amp0000660

57. Levkovich I, Shinan-Altman S. Impact of the COVID-19 pandemic on stress and emotional reactions in Israel: a mixed-methods study. *Int Health*. (2021) 13:358–66. doi: 10.1093/inthealth/ihaa081

58. Marciano H, Kimhi S, and Eshel Y. Predictors of individual, community and national resiliencies of Israeli, Jews, and Arabs. *Int J Psychol*. (2019) 55:553–61. doi: 10.1002/ijop.12636

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Framing Public Opinion on Physician-Patient Conflicts on Microblog: A Comparative Content Analysis

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Introduction: Physician–patient conflicts in China have increased more than ten times from the 2000s to the 2020 and arouse heated discussions on microblog. The outbreak of the COVID-19 pandemic is believed to have brought a turnaround in the physician–patient relationship. However, little is known about the similarities and differences among the views of opinion leaders from the general public, physicians, and media regarding physician–patient conflict incidents on microblog, and whether the outbreak had an impact on this.

Objective: This study aims to explore how opinion leaders from the physicians, general public, and media framed posts on major physician–patient conflict incidents on microblog, and compare the microblog post frames before and after the COVID-19 pandemic. The findings will provide more objective evidence of the attitudes and perspectives of the health professionals, general public, and media on physician–patient conflicts, and the influence of pandemics on physician–patient relationship.

Methods: A comparative content analysis was conducted to examine the posts ($n =$ 941) of microblog opinion leaders regarding major physician–patient conflicts in China from 2012 to 2020.

Results: Post-pandemic microblog posts used more cooperation, positive and negative frames, but mentioned less health-related knowledge; no difference was found in the use of conflict and attribution frames. Results on the use of frames by opinion leaders from different communities found that the media used more conflict, cooperation, attribution, and positive frames, but used fewer negative frames and mentioned less health-related knowledge than general public and physicians. Results on the use of frames for different incidents found that incidents of violence against physicians used more cooperation, positive and negative frames and mentioned less health-related knowledge; in the contract, incidents of patient death used more attribution frames and mentioned more health-related knowledge.

Conclusion: The physician and general public opinion leaders share some similarities in their post frames, implying that no fundamental discrepancy between them regarding physician–patient conflict incidents. However, the imbalanced use of frames by media

microblogger would cultivate and reinforce the public perception of physician–patient contradictions. After the COVID-19 pandemic, more cooperation and positive frames were used in the posts, indicating an improvement in the physician–patient relationship in China.

Keywords: physician-patient relationship, opinion leader, framing, microblog, COVID-19

INTRODUCTION

Physician–patient conflicts have increased more than ten times from the 2000's to the 2010's in China (1) and have a substantial effect on physician–patient mistrust and relationship (2). Nie et al. (2) found that intense physician–patient conflicts increased the physicians' defense, further exacerbated physician–patient communications, and produced poorer health outcomes and negative news reports, finally leading to more serious physician–patient mistrusts and conflicts. Many factors account for the poor patient–physician relationship in China, including the complicated medical system, limited medical resources compared to the large population, and high medical costs (3). These factors lead to limited patient encounter time and insufficient physician–patient communication, which further cause dissatisfaction and even serious conflicts between physicians and patients (3, 4).

Social media offers an optional channel for physician–patient communication. Compared to face-to-face and online e-health service communications, microblog provide a more open, comfortable, and relatively equal platform for physician–patient communication (5, 6). When communicating on a microblog, patients are usually not in an emergency situation, and physicians are less stressed as they are away from their workplace. It is more valuable in Asian contexts since online communication can reduce patient's inhibitions of expressing their concerns and emotions in face-to-face situations and could possibly strengthen physician–patient communication (7). Therefore, an increasing number of physicians and patients worldwide have turned to microblog to communicate, disseminate, and discuss health-related issues (8, 9).

Opinion leaders refer to people who influence other's opinions or attitudes on social issues (10), including health education and promotion (11). Microbloggers can be verified by microblog platforms as health professionals, media, or celebrities. Some of these verified microbloggers have attracted millions of followers on Sina Weibo. Recent studies have found that these verified microbloggers have the ability to disseminate information and share their views on social issues with their numerous followers; therefore, they act as opinion leaders on social media (12). Opinion leaders on microblog could affect public opinion regarding health topics and the adoption of healthy behaviors (13, 14), such as reinforcing the stereotypes of mental illness, tobacco use (15), and disease prevention (16). Han and Wang (13) found that verified microbloggers have higher connection scores (in-degree and out-degree) than non-verified microbloggers, and the top influential verified microbloggers hold central positions in the information flow process on health-related topics.

Physician–patient conflicts, especially violence incidents, have aroused heated discussion among microbloggers from various communities (physicians, the general public, and media) (17). It must be recognized that since the opinion leaders come from different backgrounds, they have distinct standpoints: physicians represent the health professional perspectives, the general public understands and perceives issues from a patient's perspective, and the media concentrates on physician–patient conflicts to promote audience interest and garner attention (18). The differentiated standpoints lead to different concerns and framing strategies. Lu et al. (7) found that different stakeholders have different concerns about the online health community: patients focused on topics related to lung cancer symptoms and diabetes drugs, caregivers were more concerned about topics related to lung cancer drugs, and patients expressed more emotions than caregivers and health professionals.

Framing theory points out that media reports shape public's understanding of news story through utilizing certain reporting frames (19). Within the social media context, message frames of opinion leaders also would define trending topic's emphasis and thereby influence public's interpretation and opinion of the topic (20, 21). Message frame refers to the speaker's structured reporting or presentation style, including viewpoints, words, and sentence patterns (19, 22). Nip and Fu (20) found that media microbloggers utilized more thematic frame on corruption issues than government, independent news sources, and other microbloggers; and have more emotional expressions than other types of microbloggers. It demonstrated that opinion leaders from different communities on social media utilize different message frames to discuss news and further influence their followers' interpretations and evaluations of a specific issue or incident (20). On health issue, different stakeholders also adopt different message frames to express their opinions on microblog, which contribute to public opinion regarding health topics, the patient's adherence to their physicians, and, ultimately, the effects of the prescribed treatment (17, 18, 22, 23).

Violence against physicians in China have aggravated since 2010. Lancet called for protecting Chinese doctors on January 2020 since "the attack scale, frequency and viciousness on Chinese doctors are particularly severe" (24). Chinese health workers behaved responsibly and even devotionally during the COVID-19 pandemic. Public also showed comprehension and appreciation for physicians according to the media reports (46, 48). It was hoped that the physician–patient relationship would improve since the COVID-19 pandemic (25); however, a few physician–patient conflicts still have been reported since 2020. Therefore, a comparison analysis of opinion leader's microblog posts on physician-patient conflicts before and after

COVID-19 pandemic could provide empirical evidence for the change of public opinion and physician-patient relationship. Besides, previous studies have concentrated more on incidents of violence against physicians (26). However, patient death incidents and no death incidents causing physician–patient conflicts have also aroused public attention, such as the Yulin mother suicide incident (2017) and physician's selfies in the operating room (2014).

Previous studies on physician–patient communication and relationship mostly adopted survey or interview (27, 28), which might have self-report bias and cannot reflect the dynamic interaction process among different groups. Therefore, to systematically investigate different stakeholders' perspectives on physician–patient conflicts and the change before and after COVID-19 pandemic, this study tries to explore message frames of posts by opinion leaders from physicians, the general public, and media on major physician–patient conflicts on microblog from 2012 to 2020. Findings will extend our understanding of consensus and discrepancies between patients and physicians with respect to their cognitive roles, mutual expectations, and communication. This study will provide more objective evidence of the attitudes and perspectives of health professionals, the general public, and media on physician–patient conflicts through content analysis. Opinion leaders influence their followers' attitudes toward physician–patient topics, which may further affect physician–patient offline relationship and healthcare outcomes (2). Therefore, this study will also contribute to building a foundation for future studies on strengthening physician–patient communication, enhancing physician–patient relationship, and expanding health knowledge discussions on social media.

We focus on the frames that are applicable to physician–patient conflict incidents on microblog. Semetko and Valkenburg (31) defined the conflict, cooperation, responsibility, and valence frames (25), and these are still applicable in the social media context (17). The conflict frame captures audiences' attention by concentrating on conflicts among individuals and/or groups, whereas the cooperation frame focuses on cooperation among individuals and/or groups (29). Opinion leaders on microblog influence their followers' perceptions of reporting incidents as either cooperative or incompatible (i.e., in conflict) by utilizing the conflict or cooperation frame (30). The responsibility frame, which focuses on the responsibility attribution regarding an issue or incident (31), is used by opinion leaders or the media to promote the responsible aspects of a specific incidents (32, 33), such as physician–patient conflict incidents. The valence frame refers to the reporting of incidents in either positive or negative terms (34). Opinion leaders influence public judgment regarding an incidents or event as either good or bad using positive or negative frames, respectively (20, 35).

Besides message frames, this study also analyzes whether the message promoting health knowledge related to the incident opinion leaders on social media are found to be effective in promoting health knowledge and behavior (36). Physicians and media and opinion leaders may introduce health knowledge that is based on the discussed physician–patient incidents to promote medical knowledge among the public.

To investigate the differences in message frames used by opinion leaders from the health industry, general public, and media when expressing their opinions on physician–patient incidents, we framed the following research questions:

RQ1: How are (1) conflict, (2) cooperation, (3) responsibility, (4) positive frames, (5) negative frames, and (6) health promotion used in opinion leaders' posts regarding physician–patient conflicts on microblog?

RQ2: How do different opinion leaders' microblog posts about (1) conflict, (2) cooperation, (3) responsibility, (4) positive frames, (5) negative frames, and (6) health knowledge promotion differ in their use before and after the COVID-19 pandemic?

RQ3: What are the differences in the use of (1) conflict, (2) cooperation, (3) responsibility, (4) positive frames, (5) negative frames, and (6) health knowledge promotion among opinion leaders from the general public, physicians, and media?

RQ4: What are the differences in the use of (1) conflict, (2) cooperation, (3) responsibility, (4) positive frames, (5) negative frames, and (6) health knowledge promotion with respect to different physician–patient conflicts?

METHODS

A comparative content analysis was conducted to investigate the microblog posts of the opinion leaders from the general public, physicians, and media on physician–patient conflict incidents in China.

Selection of Microblog Platform

The posts were collected from Weibo for several reasons. According to iResearch's report, Weibo is the largest Chinese microblog with 56.6% of the market share of active users and 86.6% of the market share with respect to browsing time based on data from China's 2010 microblog market (37). Since 2012, Weibo has required all users to register with real names to improve cyber security, and provided additional verified badges to users in public interest areas (e.g., health professions) to authenticate their practitioner status and enlarge their influence (e.g., more exposure and followers). Combining these features, this study focused on discussions regarding physician–patient incidents on Weibo.

Selection of Physician–Patient Conflict Incidents

The study period ran from 2012 to 2020. The year 2012 was set as the starting time point because Weibo required all users to register with real names and provided additional verified badges, while 2020 was set as the end point so that the study could compare the differences of message frames regarding physician–patient conflict incidents before and after the pandemic. To make the results more convincing, two incidents were selected for the year 2020, the time point after the outbreak.

Physician–patient conflict incidents were selected through a survey pretest. First, the three most highly discussed physician–patient conflict incidents for each year were nominated based on media reports and online discussions (e.g., the database of Zhiweidata, Weibo trending). Subsequently, the participants in

the pretest ($n = 298$) were asked to recall details of the incidents, and those incidents that were most clearly remembered were selected as the study cases for further analysis. This included (1) the fatal attack in Harbin Hospital (2012); (2) the fatal attack in Wenling Hospital (2013); (3) "selfies" taken by physicians in the operating room (2014); (4) physician fainting in the operating room (2015); (5) the Wei Zexi incident (2016); (6) the Yulin mother incident (2017); (7) the Peking University Hospital incident (2018); (8) the Civil Aviation General Hospital incident (2019); (9) the Beijing Chao-yang Hospital incident (2020–1); and (10) the Yanqing Hospital incident (2020–2) (**Appendix 1**). The incidents were further classified according to their consequences: (1) incidents of violence against physicians (2012, 2013, 2018, 2019, 2020–1, and 2020–2), (2) no death incidents (2014 and 2015), and (3) patient death incidents (2016 and 2017).

Recruitment

The analysis unit was the Weibo posts that discussed the nominated physician–patient incident. Previous studies found that public discussions on Weibo have limited timeliness; public engagement reaches a peak within 5 days, then declines markedly, and almost stops within a week (22, 38). Therefore, we set the unit of time to seven days after the first exposure on Weibo. For non-criminal incidents, posts were collected for seven days after their first exposure on Weibo; for criminal incidents, the analysis time was extended by another seven days after the trial.

Eligible posts were obtained in three steps (see **Appendix 2**). First, preliminary collection. All Weibo posts that discussed the selected incidents were captured *via* (1) an existing database platform (Zhiweidata, one of the most complete and authoritative platforms for detecting, recording, and preserving the top-discussed incidents on multiple social media platforms in mainland China), or (2) crawler software (GooSeeker) using keyword searches (e.g., the names of the physician, patient, and hospital). Second, opinion leader selection. Information on the microbloggers who published these posts was collected. For each incident, the study selected the key opinion leaders based on the number of followers, incident-related posts, and retweeted posts and comments, then classifies them into three categories based on their practitioner status as verified by Weibo: media, physician, and general public, and finally selected the top three most influential Weibo users from these three categories as the opinion leaders for that incident. Since some microbloggers acted as opinion leaders in more than one incident, for instance, People's Daily was selected as the opinion leader in eight of the ten incidents. Therefore, a total of 55 opinion leaders were selected instead of 90 (3 most influential microbloggers × 3 account types × 10 incidents), including 12, 23, and 20 opinion leaders from the media, general public, and physicians, respectively. Third, final data collection. For each incident, we collected all posts that discussed the incident and were posted by the selected opinion leaders resulting in a total of 941 posts. By incident types: (1) incidents of violence against physicians, $n = 661$; (2) no death incidents, $n = 67$; and (3) patient death incidents, $n = 213$. By opinion leader types: (1) media opinion leader, $n = 430$; (2)

general public opinion leader, $n = 182$; and (3) physician opinion leader, $n = 329$.

The large difference between the sub-sample sizes might be attributed to the incident's consequences and accompanying emotions. Weibo is a venue to not only browse information but also vent emotions (39). Death-related incidents are believed to result in a larger discussion on Weibo (22), because negative emotions arouse efficient information processing and subsequently enhance people's engagement (40).

Coding

The coding scheme was developed based on previous studies (32) and was modified to match our specific research setting and research purposes. The initial coding scheme followed the generic framework in the literature, that is, conflict, responsibility, cooperation, and valence frames (positive and negative aspects of an event). Although these frames are well practiced in news reports, an increasing number of studies suggest that they can also be applied to social media (41). When discussing conflict incidents, Chinese netizen's concerns include not only the parties involved, but also the government and society, and tend to require official media and opinion leaders objectively inform and evaluate the incidents and guide the public to establish the right values. For physician–patient incident specifically, people incline to go beyond the incident and expand the discussion to the current situation of physician–patient relationship and how to improve it (42). Opinion leaders will increase the general public's understanding of physicians by promoting health literacy in hopes of improving the physician–patient relationship. Hence, promotion of health knowledge was also included in the coding scheme (43).

The conflict frame was constructed based on whether the microblog posts mentioned the disagreement between (1) patient or/and patient's family and physician; (2) patient and the public opinion; (3) physician and the public opinion; and (4) two or more sides in the patient/patient's families, physician, and public opinion involved in the incident.

The cooperation frame was operated based on whether the microblog posts mentioned the cooperation between patient/patient's family and physician in the specific incident, and whether it mentioned cooperation in the broader discussion of the physician–patient relationship. Four categories were built to reflect the different dimensions of physician–patient cooperation: (1) a good communication environment, (2) physician's efforts, that is, to better understand patient's concerns, (3) patient's efforts, that is, to well understand physician's suggestions, and (4) cooperation in other formats.

The attribution frame refers to the posts that are responsible for the specific incident, for instance, (1) society/government, (2) physician/hospital, and (3) patient/patient's family. The positive and negative frames judged whether the posts discussed the positive and negative sides, and each frame was adopted in all three categories. It should be noted that the positive and negative sides encompassed not only the evaluation of the nature of the incident, but also the outlook on the physician–patient relationship.

The promotion of health knowledge identified whether the posts mentioned medical knowledge relevant to the issue, and two categories were used to develop the frame: (1) scientific knowledge directly related to the incident (e.g., knowledge of the specific disease that causes the death of the patient), and (2) other scientific knowledge related to the incident (e.g., knowledge of painless labor in mother-related incidents) (see **Tables 1a,b** for details).

A yes–no binary coding strategy was used to indicate whether the posts included a particular framing item. The value of each frame was calculated by averaging the scores of the framing items. Two well-trained coders analyzed all the posts. When disagreements occurred, the authors and two coders collaboratively reviewed and discussed the posts to determine the content frames. The Krippendorff's alpha for the coding schemes was 0.866 and reached an acceptable level.

RESULTS

To answer the research questions, we performed t-tests, one-way analyses of variance (ANOVA) and multivariate analyses of variance (MANOVA) using a bootstrap method ($N = 1,000$), which are described in detail in the respective sections. All statistical analyses were performed using IBM SPSS 26.

Overall Message Frames Usage

RQ1 addressed the use of five frames and promotion of health knowledge in opinion leader's microblog posts regarding physician–patient incidents. Overall, the conflict frame ($n = 372$) was the most dominant one, followed by the negative frame ($n = 320$), attribution frame ($n = 308$), and positive frame ($n = 305$). The use of the cooperation frame ($n = 103$) and health knowledge promotion ($n = 89$) was significantly less (**Table 1**). According to paired samples t-tests, the conflict frame ($M = 0.125$) was used more than the cooperation frame ($M = 0.043$), $t_{(940)} = 10.969$, $p < 0.001$, while the difference between the negative frame ($M = 0.230$) and the positive frame ($M = 0.231$) was not significant ($p = 0.971$).

Changes Before and After COVID-19

RQ2 aimed to identify the differences in the use of message frames before and after the COVID-19 pandemic. Considering the potential error caused by unequal sample size, we performed Welch's t-test to answer this question. Compared to the pre-pandemic posts, the post-pandemic ones used more cooperation frame (M $_{pre-pandemic}$ = 0.020, M $_{post-pandemic}$ = 0.129; Welch's $t = -7.324$, $p < 0.001$), positive frame (M $_{pre-pandemic}$ = 0.153, M $_{post-pandemic}$ = 0.521; Welch's $t = -11.009$, $p < 0.001$), and negative frame (M $_{pre-pandemic}$ = 0.206, M $_{post-pandemic}$ = 0.320; Welch's $t = -3.385$, $p < 0.001$). In contrast, pre-pandemic posts mentioned less health-related knowledge (M $_{pre-pandemic}$ = 0.062, M $_{post-pandemic}$ = 0.010; Welch's $t = 5.820$, $p < 0.001$). However, no significant difference was found in the use of conflict and attribution frames, Welch's $t = 1.872$, $p = 0.062$ and Welch's $t = 1.948$, $p = 0.052$, respectively (**Table 2**).

We further tested the use of the message frame by opinion leaders from different communities before and after the COVID-19 pandemic. The results indicated that, for the media opinion leaders, the use of cooperation and positive frames significantly increased after COVID-19; M $_{pre-pandemic}$ = 0.032, M $_{post-pandemic}$ = 0.153; Welch's $t = -5.977$, $p < 0.001$; and M $_{pre-pandemic}$ = 0.251, M $_{post-pandemic}$ = 0.664; Welch's $t = -9.878$, $p < 0.001$, respectively. In contrast, the use of conflict and attribution frames significantly decreased after COVID-19; M $_{pre-pandemic}$ = 0.175, M $_{post-pandemic}$ = 0.074; Welch's $t = 6.423$, $p < 0.001$; and M $_{pre-pandemic}$ = 0.186, M $_{post-pandemic}$ = 0.102; Welch's $t = 3.953$, $p < 0.001$, respectively. However, the use of negative frame and promotion of health knowledge was insignificant (Welch's $t = 0.372$, $p = 0.710$ and Welch's $t = 1.051$, $p = 0.294$, respectively).

Very similar results were found regarding the variations in the use of cooperation and positive frames and health knowledge promotion for the general public opinion leaders. The use of cooperation and positive frames significantly increased after COVID-19, and health knowledge promotion significantly decreased; M $_{pre-pandemic}$ = 0.008, M $_{post-pandemic}$ = 0.080; Welch's $t = -2.260$, $p = 0.033$; M $_{pre-pandemic}$ = 0.062, M $_{post-pandemic}$ = 0.387; Welch's $t = -3.843$, $p < 0.001$; and M $_{pre-pandemic}$ = 0.112, M $_{post-pandemic}$ = 0.020; $t_{(180)} = 3.412$, $p = 0.001$, respectively. However, no significant results were found regarding the use of conflict, attribution, and negative frames; Welch's $t = 0.104$, $p = 0.917$; Welch's $t = 1.991$, $p = 0.052$; and Welch's $t = -1.391$, $p = 0.175$, respectively.

For physician opinion leaders, the use of use of conflict (M $_{pre-pandemic}$ = 0.107, M $_{post-pandemic}$ = 0.193; Welch's $t = -3.212$, $p = 0.002$), cooperation (M $_{pre-pandemic}$ = 0.013, M $_{post-pandemic}$ = 0.099; Welch's $t = -2.955$, $p = 0.005$), positive (M $_{pre-pandemic}$ = 0.094, M $_{post-pandemic}$ = 0.258; Welch's $t = -2.882$) and negative frames (M $_{pre-pandemic}$ = 0.230, M $_{post-pandemic}$ = 0.648; Welch's $t = -6.224$, $p < 0.001$) significantly increased after COVID-19, whereas the promotion of health knowledge significantly decreased (M $_{pre-pandemic}$ = 0.076, M $_{post-pandemic}$ = 0.000; Welch's $t = 6.499$, $p < 0.001$). No significant results were found regarding the use of attribution, Welch's $t = -1.449$, $p = 0.152$ (**Table 3**).

Differentiated Message Frame Use by Opinion Leaders From Different Communities

MANOVA was run to address RQ3 about the overall differences in message frames among the opinion leaders from the general public, physicians, and media (**Table 4**); a series of ANOVA were conducted to measure the specific differences for each code item (**Table 1a**); paired sample t-test was used to compare the use of valance frames among different types of microbloggers.

The MANOVA results indicated an overall difference in post framing by microblogger's type: $F_{(12,1864)} = 16.287$, $p < 0.001$; Wilk's $\Lambda = 0.819$; partial $\eta^2 = 0.095$.

The post-hoc tests using Tukey's HSD revealed that media's use of the conflict frame ($M = 0.146$) was significantly higher than that of the general public opinion leaders ($M = 0.082$), $p < 0.001$; however, no significant difference was identified between the media and the physicians ($M = 0.121$, $p = 0.114$) and between

TABLE 1a | Overall landscape of the frames uses by opinion leader types (bootstrapping $n = 2,000$).

Category	Coding description	Media	Public	Physician	F	p-value
		n (mean)	n (mean)	n (mean)	df = 2	
Conflict						
Physician-patient conflict	Disagreement between patient/patient's family and doctor	147 (0.34)[a]	17 (0.09)[b]	81 (0.25)[c]	21.648	<0.001
Patient-public disagreement	Disagreement between patient and the public opinion	11 (0.03)[a]	4 (0.02)[a]	9 (0.03)[a]	0.068	0.934
Physician-public disagreement	Disagreement between doctor and the public opinion	17 (0.04)[a]	18 (0.10)[b]	24 (0.07)[ab]	4.312	0.014
General conflict	Disagreement of two sides or to more than two sides of the problem or issue	77 (0.18)[a]	21 (0.12)[a]	45 (0.14)[a]	2.470	0.085
		(0.146)	(0.082)	(0.121)	Mean=0.125	
Cooperation						
Cooperation	Cooperation between patient and doctor	58 (0.14)[a]	5 (0.03)[b]	15 (0.05)[b]	14.735	<0.001
Communication	Good communication between patient/ patient's family and doctor	24 (0.06)[a]	3 (0.02)[b]	9 (0.03)[ab]	3.520	0.030
Physician's understanding	Patient's concerns are well understood by the doctor	17 (0.04)[a]	1 (0.00)[b]	7 (0.02)[ab]	3.150	0.043
Patient's understanding	Doctors' views are well understood by the patient	14 (0.03)[a]	4 (0.02)[a]	4 (0.01)[a]	1.790	0.182
		(0.066)	(0.018)	(0.027)	Mean = 0.043	
Attribution						
Government	Society/government has the responsibility to solve the problem	114 (0.27)[a]	40 (0.22)[ab]	55 (0.17)[b]	5.219	0.006
Physician	Doctors/hospital have the responsibility to solve the problem	47 (0.11)[a]	14 (0.08)[ab]	18 (0.06)[b]	3.701	0.025
Patient	Patient or family has the responsibility to solve the problem	48 (0.11)[a]	13 (0.07)[a]	28 (0.09)[a]	1.472	0.230
		(0.162)	(0.123)	(0.102)	Mean=0.134	
Positive						
Bright side	Emphasize the bright side of the case/issue	184 (0.43)[a]	25 (0.14)[b]	60 (0.18)[b]	42.023	<0.001
Advantage	General advantage or specific benefit of the case/issue for any side	134 (0.31)[a]	15 (0.08)[b]	34 (0.10)[b]	37.375	<0.001
Future benefit	Promising development or praise the current state of the parent-doctor relationship	156 (0.36)[a]	18 (0.10)[b]	25 (0.08)[b]	61.322	<0.001
		(0.367)	(0.107)	(0.255)	Mean=0.231	
Negative						
Dark side	Emphasize the dark side of the case/issue	75 (0.17)[a]	52 (0.29)[b]	119 (0.36)[b]	17.820	<0.001
Disadvantage	General disadvantage or specific cost of the case/issue for any side	95 (0.22)[ab]	30 (0.17)[a]	87 (0.26)[b]	3.316	0.037
Future cost	Problematic future development or criticize the current state of the parent-doctor relationship	74 (0.17)[a]	31 (0.17)[a]	87 (0.26)[b]	5.690	0.003
		(0.189)	(0.207)	(0.297)	Mean=0.230	
Popular medical science						
General knowledge	Scientific knowledge about the disease in the issue	4 (0.01)[a]	5 (0.03)[a]	9 (0.03)[a]	2.040	0.131
Specific knowledge	Issue-related knowledge	14 (0.03)[a]	31 (0.17)[b]	33 (0.10)[c]	17.552	<0.001
		(0.021)	(0.099)	(0.064)	Mean=0.051	

a, b, c, different superscripts indicate the existence of a statistically significant difference.

(Continued)

TABLE 1b | Overall landscape of the frames uses by opinion incident types (bootstrapping $n = 2,000$).

Category	Coding description	Violence against physicians	No-death	Patient-death	F	p-value
		n (mean)	n (mean)	n (mean)	df = 2	
Conflict						
Physician-patient conflict	Disagreement between patient/patient's family and doctor	215 (0.33)[a]	0 (0.00)[b]	30 (0.14)[c]	28.464	<0.001
Patient-public disagreement	Disagreement between patient and the public opinion	8 (0.01)[a]	0 (0.00)[a]	16 (0.08)[b]	14.185	<0.001
Physician-public disagreement	Disagreement between doctor and the public opinion	23 (0.04)[a]	15 (0.22)[b]	21 (0.10)[c]	22.482	<0.001
General conflict	Disagreement of two sides or to more than two sides of the problem or issue	88 (0.13)[a]	9 (0.13)[ab]	46 (0.22)[b]	4.402	0.013
		(0.126)	(0.090)	(0.133)	Mean = 0.125	
Cooperation						
Cooperation	Cooperation between patient and doctor	71 (0.11)[a]	5 (0.08)[ab]	2 (0.01)[b]	10.406	<0.001
Communication	Good communication between patient/ patient's family and doctor	32 (0.05)[a]	2 (0.03)[ab]	2 (0.01)[b]	3.417	0.033
Physician's understanding	Patient's concerns are well understood by the doctor	25 (0.04)[a]	0 (0.00)[ab]	0 (0.00)[b]	5.486	0.004
Patient's understanding	Doctors' views are well understood by the patient	19 (0.03)[a]	3 (0.05)[ab]	0 (0.00)[b]	3.654	0.026
		(0.056)	(0.037)	(0.005)	Mean=0.043	
Attribution						
Government	Society/government has the responsibility to solve the problem	153 (0.23)[a]	4 (0.06)[b]	52 (0.24)[a]	5.630	0.004
Physician	Doctors/hospital have the responsibility to solve the problem	18 (0.03)[a]	10 (0.15)[b]	51 (0.24)[c]	54.724	<0.001
Patient	Patient or family has the responsibility to solve the problem	76 (0.12)[a]	0 (0.00)[b]	13 (0.06)[b]	6.575	0.001
		(0.125)	(0.070)	(0.182)	Mean=0.134	
Positive						
Bright side	Emphasize the bright side of the case/issue	226 (0.34)[a]	18 (0.27)[a]	25 (0.12)[b]	20.841	<0.001
Advantage	General advantage or specific benefit of the case/issue for any side	167 (0.25)[a]	3 (0.05)[b]	13 (0.06)[b]	25.323	<0.001
Future benefit	Promising development or praise the current state of the parent-doctor relationship	198 (0.30)[a]	1 (0.02)[b]	0 (0.00)[b]	58.019	<0.001
		(0.299)	(0.110)	(0.060)	Mean=0.231	
Negative						
Dark side	Emphasize the dark side of the case/issue	188 (0.28)[a]	3 (0.05)[b]	55 (0.26)[a]	9.131	<0.001
Disadvantage	General disadvantage or specific cost of the case/issue for any side	171 (0.26)[a]	5 (0.08)[b]	36 (0.17)[b]	8.570	<0.001
Future cost	Problematic future development or criticize the current state of the parent-doctor relationship	159 (0.24)[a]	1 (0.02)[b]	32 (0.15)[c]	12.305	<0.001
		(0.261)	(0.045)	(0.193)	Mean=0.230	
Popular medical science						
General knowledge	Scientific knowledge about the disease in the issue	11 (0.02)[a]	0 (0.00)[a]	7 (0.03)[a]	1.834	0.160
Specific knowledge	Issue-related knowledge	37 (0.06)[a]	13 (0.19)[b]	28 (0.13)[b]	12.167	<0.001
		(0.036)	(0.097)	(0.082)	Mean=0.051	

a, b, c, different superscripts indicate the existence of a statistically significant difference.

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TABLE 2 | Mean and standard deviations of the Weibo frames before/after the pandemic (n = 941).

	Pre-pandemic (n = 742)	Post-pandemic (n = 199)	Welch's t	p-value
Conflict	0.130 (0.184)	0.107 (0.147)	1.872	0.062
Cooperation	0.020 (0.098)	0.129 (0.205)	−7.324	<0.001
Attribution	0.140 (0.213)	0.109 (0.198)	1.948	0.052
Positive	0.153 (0.308)	0.521 (0.444)	−11.009	<0.001
Negative	0.206 (0.338)	0.320 (0.440)	−3.385	<0.001
Promotion of health knowledge	0.062 (0.177)	0.010 (0.086)	5.820	<0.001

95% CI refers to 95% confidence interval.

TABLE 3 | Mean and standard deviations of the Weibo frames before/after the pandemic among trilateral opinion leaders.

	Pre-pandemic (n = 742)	Post-pandemic (n = 199)	Welch's t	p-value
Media				
Conflict	0.175 (0.198)	0.074 (0.119)	6.423	<0.001
Cooperation	0.032 (0.121)	0.153 (0.210)	−5.977	<0.001
Attribution	0.186 (0.222)	0.102 (0.187)	3.953	<0.001
Positive	0.251 (0.382)	0.664 (0.407)	−9.878	<0.001
Negative	0.193 (0.335)	0.179 (0.358)	0.372	0.710
Popular medical science	0.024 (0.115)	0.012 (0.101)	1.051	0.294
General public				
Conflict	0.083 (0.156)	0.080 (0.119)	0.104	0.917
Cooperation	0.008 (0.072)	0.080 (0.157)	−2.260	0.033
Attribution	0.132 (0.226)	0.067 (0.136)	1.991	0.052
Positive	0.062 (0.185)	0.387 (0.416)	−3.843	<0.001
Negative	0.191 (0.316)	0.307 (0.396)	−1.391	0.175
Popular medical science	0.112 (0.224)	0.020 (0.100)	3.412	0.001
Physician				
Conflict	0.107 (0.172)	0.193 (0.181)	−3.212	0.002
Cooperation	0.013 (0.079)	0.099 (0.210)	−2.955	0.005
Attribution	0.094 (0.184)	0.145 (0.240)	−1.449	0.152
Positive	0.094 (0.229)	0.258 (0.401)	−2.882	0.006
Negative	0.230 (0.353)	0.648 (0.464)	−6.224	<0.001
Popular medical science	0.076 (0.194)	0.000 (0.000)	6.499	<0.001

TABLE 4 | Mean and standard deviations of the Weibo frames in different types of opinion leaders.

Account type	Conflict	Cooperation	Attribution	Positive	Negative	Popular medical science
Media (n = 430)	0.146 (0.185)[a]	0.066 (0.161)[a]	0.162 (0.216)[a]	0.367 (0.431)[a]	0.189 (0.342)[a]	0.021 (0.111)[a]
General public (n = 182)	0.082 (0.151)[b]	0.018 (0.091)[b]	0.123 (0.216)[ab]	0.107 (0.255)[b]	0.207 (0.329)[a]	0.099 (0.213)[b]
Physician (n = 329)	0.121 (0.176)[a]	0.027 (0.115)[b]	0.102 (0.195)[b]	0.121 (0.270)[b]	0.297 (0.403)[b]	0.064 (0.180)[c]
All posts (n = 941)	0.125 (0.177)	0.043 (0.136)	0.134 (0.210)	0.231 (0.372)	0.230 (0.365)	0.051 (0.163)
$F_{(2,938)}$	8.672	11.785	7.925	60.105	8.715	16.684
p	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

a, b, c, different superscripts indicate the existence of a statistically significant difference.

TABLE 5 | Mean and standard deviations of the Weibo frames in different types of physician-patient incident.

Incident type	Conflict	Cooperation	Attribution	Positive	Negative	Popular medical science
Incidents of violence against physicians ($n = 661$)	0.126 (0.163)[a]	0.056 (0.155)[a]	0.125 (0.204)[a]	0.299 (0.414)[a]	0.261 (0.399)[a]	0.036 (0.146)[a]
No-death incident ($n = 67$)	0.090 (0.142)[a]	0.037 (0.100)[ab]	0.070 (0.148)[a]	0.110 (0.187)[b]	0.045 (0.141)[b]	0.097 (0.199)[b]
Patient-death incident ($n = 213$)	0.133 (0.223)[a]	0.005 (0.048)[b]	0.182 (0.237)[b]	0.060 (0.150)[b]	0.193 (0.271)[c]	0.082 (0.192)[b]
All posts ($n = 941$)	0.125 (0.177)	0.043 (0.136)	0.134 (0.210)	0.231 (0.372)	0.230 (0.365)	0.051 (0.163)
$F_{(2,938)}$	1.561	11.628	9.412	40.076	12.467	9.383
p-value	0.210	<0.001	<0.001	<0.001	<0.001	<0.001

a, b, c, different superscripts indicate the existence of a statistically significant difference.

the general public and the physicians ($p = 0.052$). Item-specific tests suggested that the media opinion leaders concentrated more on physician-patient conflict ($M_{media} = 0.34$) in their posts than the general public ($M_{public} = 0.09$, $p < 0.001$) and the physician opinion leaders ($M_{physician} = 0.25$, $p = 0.007$). Similarity, the overall use of cooperation frame was significantly higher by media opinion leaders ($M_{media} = 0.066$) than that of the general public opinion leaders ($M_{public} = 0.018$, $p < 0.001$) and the physician opinion leaders ($M_{physician} = 0.027$, $p < 0.001$), but the difference between general public and physicians opinion leaders was insignificant ($p = 0.767$). The following item-specific tests showed that media opinion leaders emphasized general cooperation ($M_{media} = 0.14$, $M_{public} = 0.03$, $p < 0.001$), physician-patient communication ($M_{media} = 0.06$, $M_{public} = 0.02$, $p = 0.050$), and physician's understanding ($M_{media} = 0.04$, $M_{public} = 0.00$, $p = 0.044$) more than general public opinion leaders. In general, the media use attribution frame significantly higher than that of the physician opinion leaders ($M_{media} = 0.162$, $M_{physician} = 0.102$, $p < 0.001$), but the difference between the opinion leaders from the general public and physicians was insignificant ($p = 0.580$); following item-specific tests found that media tend to attribute the responsibility to governmental ($M_{media} = 0.27$, $M_{physician} = 0.17$, $p = 0.004$) and physician ($M_{media} = 0.11$, $M_{physician} = 0.06$, $p = 0.020$) than the physician opinion leaders.

Regarding the use of valance frames, the media use positive frame significantly higher than that of the general public ($M_{media} = 0.367$, $M_{public} = 0.107$, $p < 0.001$) and the physician opinion leaders ($M_{physician} = 0.121$, $p < 0.001$); but the difference between the opinion leaders from the general public and physicians was insignificant ($p = 0.906$). Regarding the use of the negative frame, the physicians' use ($M = 0.297$) was significantly higher than that of both the media ($M = 0.189$; $p < 0.001$) and general public ($M = 0.207$; $p = 0.019$); the difference between the media and the general public was insignificant ($p = 0.855$). Regarding health knowledge promotion, media ($M = 0.021$) was less likely to mention health knowledge than the general public ($M = 0.099$; $p < 0.001$) and physicians ($M = 0.064$, $p = 0.001$), and the physicians mentioned it less than the

general public ($p = 0.044$). Paired sample t-test indicated that media opinion leaders used more positive than negative frames ($M_{positive} = 0.431$, $M_{negative} = 0.342$, $p < 0.001$), while general public ($M_{positive} = 0.255$, $M_{negative} = 0.329$, $p = 0.002$) and physician opinion leaders ($M_{positive} = 0.270$, $M_{negative} = 0.403$, $p < 0.001$) used more negative than positive frames.

Frames Used in Different Types of Incidents

RQ4 addresses whether the use of five frames and the promotion of health knowledge in the posts differed by the type of physician–patient incidents. MANOVA was used to test the overall differences (**Table 5**), and series of ANOVA were conducted to measure the specific differences for each code item (**Table 1b**), and a paired sample t-test was used to compare the differences in the use of valance frames for specific physician-patient incidents. The MANOVA results suggested an overall statistically significant difference in the framing of the posts based on incident type: $F_{(12,1864)} = 17.334$, $p < 0.001$; Wilk's $\Lambda = 0.809$; partial $\eta^2 = 0.100$.

The MANOVA results indicated that the overall use of conflict frame did not differ by the type of incident (patient death *vs.* incidents of violence against physicians, $p = 0.899$; patient death incidents *vs.* no death incidents, $p = 0.192$; and incidents of violence against physicians *vs.* no death incidents, $p = 0.234$). However, item-specific tests suggested that violence against physician incidents stressed more physician-patient conflict ($M_{physician} = 0.33$, $M_{patient} = 0.14$, $p < 0.001$), less patient-public disagreement ($M_{physician} = 0.01$, $M_{patient} = 0.08$, $p < 0.001$) and less physician-public disagreement ($M_{physician} = 0.04$, $M_{patient} = 0.10$, $p = 0.002$) than patient-death incidents. The overall use of cooperation frame in the posts regarding incidents of violence against physicians ($M = 0.056$) was significantly more than that of patient death incidents ($M = 0.005$; $p < 0.001$); neither the difference between incidents of violence against physicians and no death incidents ($M = 0.037$, $p = 0.535$) nor the difference between patient death incidents and no death incidents ($p = 0.193$) was significant; item-specific tests suggested that violence

against physician incidents emphasized general cooperation (M $_{physician}$ = 0.11, M $_{patient}$ = 0.01, $p < 0.001$), physician-patient communication (M $_{physician}$ = 0.05, M $_{patient}$ = 0.01, $p = 0.027$), physician's understanding (M $_{physician}$ = 0.04, M $_{patient}$ = 0.00, $p = 0.008$) and patient's understanding (M $_{physician}$ = 0.03, M $_{patient}$ = 0.00, $p = 0.042$) more than patient-death incidents. Overall speaking, the attribution frame was used more when discussing patient death incidents ($M = 0.182$) than incidents of violence against physicians ($M = 0.125$) and no death incidents ($M = 0.070$) at $p < 0.001$, but no difference was found between incidents of violence against physicians and no death incidents ($p = 0.103$); following item-specific tests suggested that violence against physician incidents emphasized less physician attribution (M $_{physician}$ = 0.03, M $_{patient}$ = 0.24, $p < 0.001$) and more patient attribution (M $_{physician}$ = 0.12, M $_{patient}$ = 0.06, $p = 0.049$) than patient-death incidents.

The positive frame was used more when discussing incidents of violence against physicians ($M = 0.299$) than patient death incidents ($M = 0.060$) and no death incidents ($M = 0.070$) at $p < 0.001$; the difference between patient death incidents and no death incidents was insignificant ($p = 0.579$). Likewise, the negative frame was used more in violence against physicians ($M = 0.261$) than patient death incidents ($M = 0.193$; $p = 0.042$) and no death incidents ($M = 0.045$; $p < 0.001$), and in posts discussing patient death incidents than no death incidents ($p = 0.010$). Paired sample t-test showed that no death incidents used more positive than negative frames ($p = 0.033$), patient death incidents used more negative than positive frames ($p = 0.001$), and there was no significant difference in the use of valance frames in incidents of violence against physicians ($p = 0.169$).The promotion of health knowledge was significantly less in incidents of violence against physicians ($M = 0.036$) than patient death incidents ($M = 0.082$; $p = 0.001$) and no death incidents ($M = 0.097$; $p = 0.010$), and the difference between patient death incidents and no death incidents was insignificant ($p = 0.790$).

DISCUSSION

Opinion leaders on social media engaged in constructing and influencing public's understanding these controversial incidents through utilizing different post frames. The microblog post from opinion leaders on physician-patient conflicts have become objective history texts, which enable us to explore the opinions, interplay and change of different communities on physician-patient conflict incidents. This study content analyzed the microblog post frames of media, general public and health professions opinion leaders on physician-patient conflicts in the past ten years. Through comparing the message frames among different groups, and exploring the changes in the frame of the posts before and after the COVID-19 pandemic, findings shed light on the underlying norms, interest and value propositions held by different groups. It is an important part of public opinion of physician–patient relationship (44), and also creates an objective empirical structure for further exploring physician–patient and other related health communications *via* social media.

The results indicated that the media opinion leaders used systematically biased framing of physician–patient conflicts. Among the three groups of opinion leaders, the media use more conflict frames while making less effort to promote health knowledge than the general public and physician opinion leaders. Specifically, media concentrated on physician-patient conflicts, while physician opinion leaders more focused on the disagreement between physician and public. This difference indicated that media intend to capture public's attention through portraying conflicts while physicians aimed to clarify the incidents.

The average followers of media (mean = 62,420,699) are several times those of the general public (mean = 9,891,605) and physician (mean = 2,540,837) microbloggers; hence, the media probably has a greater influence on public opinion. Media microbloggers concentrate on depicting physician–patient conflicts rather than promoting incident-related health knowledge; this type of deviation is misleading and biases the public perception, thus hurting physician–patient trust and relationship, creating encounter difficulties, and causing a vicious circle of physician–patient communication (2).

Media opinion leaders used more positive frame than negative frame. Since Chinese media are mostly stated-controlled, they tend to shape public perception of harmonious society through using positive message frame. On the other hand, general public and physician used more negative than positive frames. The significantly high use of negative frames by physician opinion leaders reflect that health profession's feelings are hurt by intense physician- patient conflicts, which will inevitably cause physician to be more cautious and self-protection even in the face-to-face communication.

It is noteworthy that negative and positive frames were more used, while attribution frame was less used in violence against physician than the other two types of conflicts. The high utilization of valence (negative/positive) frames reflect great concern and strong sentiment on violence against physician incidents. However, less utilization of attribution frames may lead to fewer reflection of the social and systematical causes of the series of malicious attack on physicians.

The general public and physician opinion leaders shared something in common: they mostly attributed the cause of conflicts to the government/society (22.7% general public and 16.7% physician), while attributing the least to the patient (7.1% general public and 8.5% physician), which indicated that both of these two groups realized the health system and limit medical care resource are main causes for physician-patient conflicts. Moreover, there are no significant differences in the use of conflict, cooperation, negative, and popular science frames, implying that no fundamental discrepancy exists between the general public and health professionals regarding physician–patient conflict incidents.

Although the tensions between physicians and patients in China have some special reasons, such as conflicts between the financial interests of health institutions and patient's appropriate treatment, and contradictions among a large number of patients and limited medical resources (45), physicians and the general public still share many common views on physician–patient

conflict incidents. By expressing and viewing other's opinions on health issues, health professionals and the general public could further promote mutual understanding, enhance public health education, and strengthen physician–patient communication, thus improving the physician–patient relationship.

After the pandemic, Chinese government has highlighted the praise of physicians and actively guided public opinion in the hope of building a more harmonious physician–patient relationship, while the selfless dedication shown by healthcare workers during the pandemic made the general public more understanding and sympathetic to physicians (46). The findings of the study corroborated these changing tends. In general, more positive, negative and cooperation frames are being utilized to construct posts of physician–patient conflicts after the COVID-19 pandemic. Specifically, media microbloggers used more positive and cooperation frames, while using less conflict and attribution frames on physician–patient incidents after the COVID-19 pandemic. This contributes to improving physician–patient relationships since negative media portrayal of physicians led to physician–patient tension (47). The public also shows more understanding and gratitude to health professionals during the COVID-19 pandemic (48). Therefore, there is an improving trend of physician–patient relationship in China, while physician–patient relationship has become intense in some other countries due to social distancing and limited diagnostic time (49, 50). Future research could further explore the changes in physician–patient communication and trust, and their influence on physician–patient relationship and patient adherence after the COVID-19 pandemic.

Although this study did not directly investigate the public's understanding and behavior to different post frames, previous studies have provided ample evidence of the significant relationship between public reactions and message frames (51, 52). Findings of this study provide empirical data structure for physician-patient communication on social media. Further efforts should be made to set up and enhance communication between health professionals and the general public on social media, since previous studies showed that Internet usage aggravated mistrust between physicians and patients in China (53). Moreover, because the media opinion leaders have a greater number of followers than the general public and physician opinion leaders on microblog, it is essential to encourage media microbloggers to make efforts to popularize medical science and use balanced news frames on health issues to enhance public health education and improve physician–patient mutual understanding and relationship.

LIMITATIONS

This study has several limitations. First, the study was conducted in China, which may limit the generalizability of the findings, especially in Western countries with different cultural backgrounds and medical systems. Future studies could further explore how to utilize online opinion leaders to promote health communication in different contexts. Second, this study did not analyse the retweets and comments of microblog posts.

Future studies should further analyse the contents of the comments and retweets of popular microblog posts to analyse the follower's reactions to the health opinion leaders. Furthermore, the completeness of the collected posts may be open to questions. It is highly likely that some influential posts were removed before the data were collected because this study involved some sensitive physician–patient incidents, such as death-related incidents, and some incidents were not the most recent. In addition, unequal sample sizes may reduce the contribution of the results, and we can only eliminate potential negative effects at the statistical level. All these conditions increase the challenges involved in accessing all the posts on each incident.

CONCLUSIONS

This study conducted a content analysis to examine how opinion leaders from the physicians, general public, and media on microblog framed posts regarding major physician–patient conflicts. The media use significantly more conflict and attribution frames and devote the least effort to promote health knowledge. This imbalanced use of news frames would cultivate and reinforce the public perception of physician–patient contradictions. More cooperation and positive frames were used after the COVID-19 pandemic, indicating an improvement in the physician–patient relationship in China.

DATA AVAILABILITY STATEMENT

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

AUTHOR CONTRIBUTIONS

WG and QG: designed the study, methodology, writing—original draft preparation, and writing—review and editing. QG: software and data curation. WG: supervision, project administration, funding acquisition, conceptualization, and resources. Both authors have read and agreed to the published version of the manuscript.

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REFERENCES

1. Chinese Medical and Health System Reform Report. *The Number of Medical Disputes in China Has Increased 10-Fold in the Past 10 Years.* Available online at: https://www.medsci.cn/article/show_article.do;jsessionid=E189CC96EDBD4489C91F5CA4A9B59414?id=ac1162312a9 (accessed December 10, 2018).

2. Nie JB, Cheng Y, Zou X, Gong N, Tucker JD, Wong B, et al. The vicious circle of patient-physician mistrust in China: health professionals' perspectives, institutional conflict of interest, and building trust through medical professionalism. *Dev World Bioeth.* (2018) 18:26–36. doi: 10.1111/dewb.12170

3. Zhong ZJ. How the doctor-patient relationship affects the patients' following of doctor's orders: from an interpersonal communication perspective. *Acad Res.* (2018) 4:67–73. Available online at: https://kns.cnki.net/kcms/detail/detail.aspx?dbcode=CJFD&dbname=CJFDLAST2018&filename=XSYJ201804010&uniplatform=NZKPT&v=c3BgPzeYa4oDFn-Yv1xuMYmNGCa5fOW2F1xB--wzEtZHAkLM4b0uk95Fmvt47RoI

4. Feng J, Li Y, Han C, Xu L, Duan L. A retrospective analysis on 418 medical disputes (in Chinese). *Chinese Hosp Manag.* (2013) 33:77–9. Available online at: https://kns.cnki.net/kcms/detail/detail.aspx?dbcode=CJFD&dbname=CJFDHIS2&filename=YYGL201309046&uniplatform=NZKPT&v=ml6c1xLKeZrCJyP5UCfZOW6_dYWOETo1jWawPfv2gqPGGj0cd3vXMBEBilAbWlvF

5. Alpert JM, Womble FE. Just What the doctor tweeted: physicians' challenges and rewards of using twitter. *Health Commun.* (2016) 31:824–32. doi: 10.1080/10410236.2015.1007551

6. Smailhodzic E, Hooijsma W, Boonstra A, Langley DJ. Social media use in healthcare: a systematic review of effects on patients and on their relationship with healthcare professionals. *BMC Health Serv Res.* (2016) 16:442. doi: 10.1186/s12913-016-1691-0

7. Lu Y, Wu Y, Liu J, Li J, Zhang P. Understanding health care social media use from different stakeholder perspectives: a content analysis of an online health community. *J Med Internet Res.* (2017) 19:e109. doi: 10.2196/jmir.7087

8. Kreps GL, Neuhauser L. New directions in eHealth communication: opportunities and challenges. *Patient Educ Couns.* (2010) 78:329–36. doi: 10.1016/j.pec.2010.01.013

9. Wu T, Deng Z, Feng Z, Gaskin DJ, Zhang D, Wang R. The effect of doctor-consumer interaction on social media on consumers' health behaviors: cross-sectional study. *J Med Internet Res.* (2018) 20:e73. doi: 10.2196/jmir.9003

10. Katz E. The two-step flow of communication: an up-to-date report on a hypothesis. *Public Opin Q.* (1957) 21:61–78. doi: 10.1086/266687

11. Valente TW, Pumpuang P. Identifying opinion leaders to promote behavior change. *Health Educ Behav.* (2017) 34:881–96. doi: 10.1177/1090198106297855

12. Hilbert M, Vasquez J, Halpern D, Valenzuela S, Arriagada E. One step, two step, network step? complementary perspectives on communication flows in twittered citizen protests. *Soc Sci Comput Rev.* (2017) 35:444–61. doi: 10.1177/0894439316639561

13. Han GK, Wang W. Mapping user relationships for health information diffusion on microblogging in china: a social network analysis of sina weibo. *Asian J Commun.* (2015) 25:65–83. doi: 10.1080/01292986.2014.989239

14. Korda H, Itani Z. Harnessing social media for health promotion and behavior change. *Health Promot Pract.* (2013) 14:15–23. doi: 10.1177/1524839911405850

15. Chu K-H, Majmundar A, Allem J-P, Soto DW, Cruz TB, Unger JB. Tobacco use behaviors, attitudes, and demographic characteristics of tobacco opinion leaders and their followers: twitter analysis. *J Med Internet Res.* (2019) 21:e12676. doi: 10.2196/12676

16. Griner SB, Thompson EL, Vamos CA, Chaturvedi AK, Vazquez-Otero C, Merrell LK, et al. Dental opinion leaders' perspectives on barriers and facilitators to HPV-related prevention. *Hum Vaccin Immunother.* (2019) 15:1856–62. doi: 10.1080/21645515.2019.1565261

17. Hu G, Han X, Zhou H, Liu Y. Public perception on healthcare services: evidence from social media platforms in China. *Int J Environ Res Public Health.* (2019) 16:1273. doi: 10.3390/ijerph16071273

18. Chen H, Gao Y. Restructure of discourse power in doctor-patient relationship. *J Commun.* (2013) 11:68–89. Available online at: https://kns.cnki.net/kcms/detail/detail.aspx?dbcode=CJFD&dbname=CJFDHIS2&filename=YANJ201311009&uniplatform=NZKPT&v=UU9SauABo0yvRYNUsO-h2cnoYgT5QlOZvJ7sX_3TvBBiBsXQtv5WaAkfTvLYVuse

19. Entman RM. Framing: toward clarification of a fractured paradigm. *J Commun.* (1993) 43:51–8. doi: 10.1111/j.1460-2466.1993.tb01304.x

20. Nip JYM, Fu K. Networked framing between source posts and their reposts: an analysis of public opinion on China's microblogs. *Inf Commun Soc.* (2016) 19:1127–49. doi: 10.1080/1369118X.2015.1104372

21. Wasike BS. Framing news in 140 characters: How social media editors frame the news and interact with audiences via twitter. *Glob Media J Can.* (2013) 6:5–23.

22. Duan G, Liao X, Yu W, Li G. Classification and prediction of violence against Chinese medical staff on the Sina microblog based on a self-organizing map: quantitative study. *J Med internet Res.* (2020) 22:e13294. doi: 10.2196/13294

23. Gamson WA, Modigliani A. Media discourse and public opinion on nuclear power: a constructionist approach. *Am J Sociol.* (1989) 95:1–37. doi: 10.1086/229213

24. Protecting Chinese doctors. *Lancet.* (2020) 395:90. doi: 10.1016/S0140-6736(20)30003-9

25. Gao B, Dong J. Does the impact of COVID-19 improve the doctor-patient relationship in China? *Am J Med Sci.* (2020) 360:305. doi: 10.1016/j.amjms.2020.05.039

26. Nie JB, Li L, Gillet G, Tucker JD, Kleinman A. The crisis of patient-physician trust and bioethics: lessons and inspirations from China. *Dev World Bioeth.* (2018) 18:56–64. doi: 10.1111/dewb.12169

27. Bauhoff S. Systematic self-report bias in health data: impact on estimating cross-sectional and treatment effects. *Heal Serv Outcomes Res Methodol.* (2011) 11:44–53. doi: 10.1007/s10742-011-0069-3

28. Althubaiti A. Information bias in health research: definition, pitfalls, and adjustment methods. *J Multidiscip Healthc.* (2016) 9:211–7. doi: 10.2147/JMDH.S104807

29. Matthes J. What's in a frame? a content analysis of media framing studies in the world's leading communication journals, 1990-2005. *Journal Mass Commun Q.* (2009) 86:349–67. doi: 10.1177/107769900908600206

30. Burscher B, Odijk D, Vliegenthart R, Rijke Mde, Vreese CHde. Teaching the computer to code frames in news: comparing two supervised machine learning approaches to frame analysis. *Commun Methods Meas.* (2014) 8:190–206. doi: 10.1080/19312458.2014.937527

31. Semetko H, Valkenburg P. Framing European politics: a content analysis of press and television news. *J Commun.* (2000) 50:93–109. doi: 10.1111/j.1460-2466.2000.tb02843.x

32. Gong W, Tu C, Jiang LC. Stigmatized portrayals of single women: a content analysis of news coverage on single women and single men in China. *J Gend Stud.* (2017) 26:197–211. doi: 10.1080/09589236.2015.1095082

33. Gross K. Framing persuasive appeals: episodic and thematic framing, emotional response, and policy opinion. *Polit Psychol.* (2008) 29:169–92. doi: 10.1111/j.1467-9221.2008.00622.x

34. Schuck ART, de Vreese CH. Between risk and opportunity. *Eur J Commun.* (2006) 21:5–32. doi: 10.1177/0267323106060987

35. Nisar MT, Prabhakarb G. Trains and twitter: firm generated content, consumer relationship management and message framing. *Transp Res Part A Policy Pract.* (2018) 113:318–34. doi: 10.1016/j.tra.2018.04.026

36. Shi J, Salmon CT. Identifying opinion leaders to promote organ donation on social media: network study. *J Med Internet Res.* (2018) 20:e7. doi: 10.2196/jmir.7643

37. Sina Commands 56% of China's Microblog Market. *Resonance.* Available online at: http://www.resonancechina.com/sina-commands-56-of-chinas-microblog-market/ (accessed September 13, 2019).

38. Liao H, Wang Y, Guan P. Topic mining and viewpoint recognition of different communicators in the transmission cycle of micro-blog public opinion. *Libr Inf Serv.* (2018) 62:77. doi: 10.13266/j.issn.0252-3116.2018.19.010

39. Ji P. Emotional criticism as public engagement: how weibo users discuss "peking university statues wear face-masks." *Telemat Informatics.* (2016) 33:514-24. doi: 10.1016/j.tele.2015.06.017

40. Marcus GE, Mackuen MB. Anxiety, enthusiasm, and the vote: the emotional underpinnings of learning and involvement during presidential campaigns. *Am Polit Sci Rev.* (1993) 87:672–85. doi: 10.2307/2938743

41. Valenzuela S, Piña M, Ramírez J. Behavioral effects of framing on social media users: How conflict, economic, human interest, and morality frames drive news sharing. *J Commun.* (2017) 67:803–26. doi: 10.1111/jcom. 12325

42. Zhao S. Research on the accurate design for promoting mainstream discourse guidance from the perspective of internet public opinion field (in Chinese). *J Sichuan Univ.* (2020) 3:12–9. Available online at: https://kns.cnki.net/kcms/d etail/detail.aspx?dbcode=CJFD&dbname=CJFDLAST2020&filename=SCDZ 202003003&uniplatform=NZKPT&v=C16la8CDkaiqRTnBpoV-D8EzsefoIY FFyUYWfhmWVHXkcBauvktzLqJGJV_AE4J

43. Theall KP, Fleckman J, Jacobs M. Impact of a community popular opinion leader intervention among African American adults in a southeastern United States community. *AIDS Educ Prev.* (2015) 27:275–87. doi: 10.1521/aeap.2015.27.3.275

44. Bosslet GT, Torke AM, Hickman SE, Terry CL, Helft PR. The patient-doctor relationship and online social networks: results of a national survey. *J Gen Intern Med.* (2011) 26:1168–74. doi: 10.1007/s11606-011-1761-2

45. Zhong ZJ, Nie J, Xie X, Liu K. How medic–patient communication and relationship influence Chinese patients' treatment adherence. *J Health Commun.* (2019) 24:29–37. doi: 10.1080/10810730.2018. 1561768

46. Liu JH. Building a new type of doctor-patient relationship to empower the construction of health China. *People Tribune.* (2021) 33:86–8. Available online at: https://kns.cnki.net/kcms/detail/detail.aspx?dbcode=CJFD&dbna me=CJFDLAST2021&filename=RMLT202133021&uniplatform=NZKPT&v =lL6ADhrA_19CCh2Fw8UtrwLCRvEnsXgNJt3sSXIYitWDm5LRsh1zEBklN z_LCF_N

47. Meng H. Understanding professional medical trouble makers. *Chin Med Guide.* (2006) 8:15–6. doi: 10.15912/j.cnki.gocm.2006. 08.005

48. Liu Q, Luo D, Haase JE, Guo Q, Wang XQ, Liu S, et al. The experiences of health-care providers during the COVID-19 crisis in China: a qualitative study. *Lancet Glob Health.* (2020) 8:e790–8. doi: 10.1016/S2214-109X(20)30204-7

49. Nwoga HO, Ajuba MO, Ezeoke UE. Effect of COVID-19 on doctor-patient relationship. *Int J Commun Med Public Health.* (2020) 7:4690. doi: 10.18203/2394-6040.ijcmph20205136

50. Assegaff S, Asri SDA, Rinaldi EA, Sutopo H, Dhani R. *Stigmatization, Dishonest Patients, and Challenges of Diagnosing COVID-19: A Review of Physician-Patient Communication in Indonesia.* Available online at: http://dx. doi.org/10.2139/ssrn.3830425 (accessed March 10, 2021).

51. Nabi RL, Gustafson A, Jensen R. Framing climate change: exploring the role of emotion in generating advocacy behavior. *Sci Commun.* (2018) 40:442–68. doi: 10.1177/1075547018776019

52. Parmer J, Baur C, Eroglu D, Lubell K, Prue C, Reynolds B, et al. Crisis and emergency risk messaging in mass media news stories: is the public getting the information they need to protect their health? *Health Commun.* (2016) 10:1215–22. doi: 10.1080/10410236.2015.1049728

53. Zhu BW, Luo JJ. Does internet use affect public trust in doctors?–empirical analysis based on data CSS2013. *Jiangsu soc sci.* (2017) 3:70–8. doi: 10.13858/j.cnki.cn32-1312/c.2017.03.011

Vaccine Hesitancy Among Religious Groups: Reasons Underlying This Phenomenon and Communication Strategies to Rebuild Trust

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Vaccine hesitancy still represents a phenomenon that undermines the effectiveness of vaccination campaigns and population protection from vaccine-preventable diseases (1, 2). Among reasons underlying this reticence, religion-related convictions probably represent the commonest (3, 4). In this paper we aimed to analyse common religious beliefs connected to vaccine hesitancy and their consequences in terms of vaccination coverage. The need of communication strategies targeted at specific religious populations was analyzed as well. A literature review was carried out in order to achieve study's objectives.

Religious reasons underpinning the vaccine hesitancy were identified for many religious groups, including Protestants, Catholics, Jewish, Muslims, Christians, Amish, Hinduist and Sikhist. For instance, porcine or non-halal ingredients content of vaccines was the main barrier identified in Muslim populations (5–7). Another reason of refusal among Muslims was related to the Ramadan and fasting period. Indeed, during the Ramadan fasting month believers have to abstain themselves from eating, drinking, perfuming or having sexual relationship from sunrise to sunset. A study carried out in Guinea revealed that 46% of Muslims and 80% of religious leaders considered that vaccination was not allowed during the Ramadan. Most cited reasons for refusal were that "Nothing should enter or leave the body during Ramadan" and that "Adverse events could lead to breaking the fast" (8). The belief in a divine fate or to a destiny was found among Muslims. It suggested that someone's disease was the will of God and that nothing should go against it, neither a vaccine (9). Objection to vaccination was also related to: faith in divine protection and healing for Protestants, Catholics, Jewish and Muslims (10); the use of aborted fetal cells for vaccines' production among Amish and Catholic communities (including during the COVID-19 outbreak when Senior Catholic leaders from the US and Canada raised ethical objections to vaccines produced using cells derived from aborted fetuses) (11, 12); the connection between the use of HPV vaccination and sexual promiscuity among Christian parents who consider this vaccine useless for their child as it was considered as a consequence of a certain sexual lifestyle (13, 14). Lastly, the results of the observational, cross-sectional, questionnaire-based study carried out by Sheik A et al. (7) revealed that religious taboos were among the main reasons for non-vaccination among Hinduism and Sikhism believers too.

Vaccine hesitancy driven by religious beliefs brings inevitable consequences for vaccination coverage too. A recent survey carried out in the US that collected HPV vaccination status among American Muslim women (15) showed that 38% of participants received a single dose of HPV while 33% completed the 3-dose schedule. This coverage was below the national estimates of HPV

vaccine initiation rates (48–65% as mentioned by the CDC). Conversely, flu shot uptake among American Muslim women was found to be higher than annual adult estimates for a comparable population in the country (71.98% vs. 39–44%). On the other hand, studies analyzing the full immunization status of children showed a higher coverage among religious groups than the rest of the population. Three studies compared religious with non-religious communities in Ghana, Uganda and Zimbabwe in terms of vaccination coverage (16–18). In particular, Budu E et al. reported higher vaccination coverage for children raised in Christian and Muslim families than children from families without religion (16). Similarly, in Uganda, the complete immunization status of children aged 0 to 1-year-old was found to be higher in the Christian community (73.8%) than in the non-Christian one (69.2%) (17). Lastly, the study conducted in Zimbabwe reported the receipt of all basic vaccinations for children aged 12–23 months for the 2010–2011 period of Christians either Apostolic, Roman Catholic, Protestant or Pentecostal/charismatic, Traditionalist and Muslim (18). All those groups had a higher vaccination coverage than participants with no religious affiliation. These considerations emphasize that the individual decision to vaccinate or not among religious groups are not only driven by the religious affiliations since positive trends can be observed among these communities despite known barriers to vaccination.

Notwithstanding these encouraging data on vaccination coverage, we believe that communication strategies targeted at populations specifically concerned are crucial and there is a need for more evaluation of these interventions. Many examples of this type of communication strategies are already in place. For instance, in the scope of the Expanded Programme on Immunization (EPI) in Pakistan, a social mobilization campaign was undertaken to reach community health workers and parents. The objective was to affirm the commitment of the Government in the provision of vaccines and to align the national standards goals and messages toward vaccination. In this campaign, local religious influencers were involved through announcements in Mosque about immunization sessions and through the mentioning of immunization significance during periodic religious sermons (19). A preventive strategy to reduce the incidence of cervical cancer among immunized women in Malaysia consisted in the providing of HPV information followed by a free vaccination. HPV awareness and barriers were assessed through a survey among 13 years old Malaysian girls. The author reported that the overall knowledge regarding HPV vaccine remained poor even after the intervention, since more girls (2.3%) reported that their religion prohibits the HPV vaccine because of its connection with sexual promiscuity (20). Another communication strategy focused on the HPV vaccination was put in place in the US, where the Intermountain West HPV Vaccination Coalition (IWHC) between 10 states and 300 diverse community members was created to improve HPV vaccination among boys and girls and to design new strategies to address HPV barriers, in population of rural and highly religious Intermountain West states (21). Members of the IWHC conducted a survey and focus groups of selected IWHC members about their experience for the 2014–2016 period in the coalition and reported the following top five facilitators to vaccination: strong provider recommendation, improved education about HPV vaccination, increased parental buy-in, focusing on cancer prevention, involving schools more in vaccination.

In conclusion, religious reasons were already known to be sources of vaccine hesitancy. Since vaccination behaviors are not predicted by religion alone but are the results of multiple factors at the individual level, finding the proper effective communication strategy could be a tall order. In order to be effective, we believe that a communication strategy should be based on transparency to build trust, dialogue to involve the targeted community, identify its potential reluctances and address them through scientific exchange of information. The application of the behavior change communication (BCC), as an interactive process aimed to develop tailored messages and promote community behavior change (22), will indeed play a key role in this specific clinical setting.

With these characteristics and together with the continuous monitoring of vaccination coverage, it would be possible to achieve global immunization goals and effectively contrast religious-related vaccine concerns not consistent with scientific knowledge. Lastly, these strategies could contribute to improve vaccination coverage during worldwide emergencies such as the current COVID-19 pandemic.

AUTHOR CONTRIBUTIONS

AKV developed the concept. AKV and CS wrote the paper. AKV, CS, DC-M, and AC made substantial contributions to the acquisition, analysis, or interpretation of data for the work and approved the final version of the manuscript to be published. DC-M and AC revised the paper for important intellectual content. All authors contributed to the article and approved the submitted version.

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REFERENCES

1. Ziello A, Scavone C, Di Battista ME, Salvatore S, Di Giulio Cesare D, Moreggia O, et al. Influenza vaccine hesitancy in patients with multiple sclerosis: a monocentric observational study. *Brain Sci.* (2021) 11:890. doi: 10.3390/brainsci11070890

2. Scavone C, Sessa M, Clementi E, Rossi F, Capuano A. Italian immunization goals: a political or scientific heated debate? *Front Pharmacol.* (2018) 9:574. doi: 10.3389/fphar.2018.00574

3. Rutjens BT, Sutton RM, van der Lee R. Not all skepticism is equal: exploring the ideological antecedents of science acceptance and rejection. *Pers Soc Psychol Bull.* (2018) 44:384–405. doi: 10.1177/0146167217741314

4. Larson HJ, de Figueiredo A, Xiahong Z, Schulz WS, Verger P, Johnston IG, et al. The state of vaccine confidence 2016: global insights through a 67-country survey. *EBioMedicine.* (2016) 12:295–301. doi: 10.1016/j.ebiom.2016.08.042

5. Padmawati RS, Heywood A, Sitaresmi MN, Atthobari J, MacIntyre CR, SoenartoY, et al. Religious and community leaders' acceptance of rotavirus vaccine introduction in Yogyakarta, Indonesia: a qualitative study | BMC Public Health | Full Text. Available online at: https://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-019-6706-4

6. Syiroj ATR, Pardosi JF, Heywood AE. Exploring parents' reasons for incomplete childhood immunisation in Indonesia. *Vaccine.* (2019) 37:6486–93. doi: 10.1016/j.vaccine.2019.08.081

7. Sheikh A, Iqbal B, Ehtamam A, Rahim M, Shaikh HA, Usmani HA, et al. Reasons for non-vaccination in pediatric patients visiting tertiary care centers in a polio-prone country. *Arch Public Health.* (2013) 71:19. doi: 10.1186/0778-7367-71-19

8. Peiffer-Smadja N, Ouedraogo R, D'Ortenzio E, Cissé PN, Zeggani Z, Beavogui AH, et al. Vaccination and blood sampling acceptability during Ramadan fasting month: A cross-sectional study in Conakry, Guinea. *Vaccine.* (2017) 35:2569–74. doi: 10.1016/j.vaccine.2017.03.068

9. Murakami H, Kobayashi M, Hachiya M, Khan ZS, Hassan SQ, Sakurada S. Refusal of oral polio vaccine in northwestern Pakistan: A qualitative and quantitative study. *Vaccine.* (2014) 32:1382–7. doi: 10.1016/j.vaccine.2014.01.018

10. Williams JTB, O'Leary ST. Denver religious leaders' vaccine attitudes, practices, and congregational experiences. *J Relig Health.* (2019) 58:1356–67. doi: 10.1007/s10943-019-00800-2

11. Wenger OK, McManus MD, Bower JR, Langkamp DL. Underimmunization in Ohio's Amish: parental fears are a greater obstacle than access to care. *Pediatrics.* (2011) 128:79–85. doi: 10.1542/peds.2009-2599

12. Wadman M. Vaccines that use human fetal cells draw fire. *Science.* (2020) 368:1170–1. doi: 10.1126/science.368.6496.1170

13. Joseph NP, Shea K, Porter CL, Walsh JP, Belizaire M, Estervine G, et al. Factors associated with human papillomavirus vaccine acceptance among Haitian and African-American parents of adolescent sons. *J Natl Med Assoc.* (2015) 107:80–8. doi: 10.1016/S0027-9684(15)30028-6

14. Galbraith-Gyan KV, Lechuga J, Jenerette CM, Palmer MH, Moore AD, Hamilton JB, et al. vaccine acceptance among African-American mothers and their daughters: an inquiry grounded in culture. *Ethn Health.* (2019) 24:323–40. doi: 10.1080/13557858.2017.1332758

15. Hearld KR, Budhwani H. Human papillomavirus (HPV) and influenza vaccine behavior among Muslim women in the United States. *Health Care Women Int.* (2020) 41:532–42. doi: 10.1080/07399332.2019.1623797

16. Budu E, Darteh EKM, Ahinkorah BO, Seidu A-A, Dickson KS. Trend and determinants of complete vaccination coverage among children aged 12-23 months in Ghana: Analysis of data from the 1998 to (2014). *Ghana Demographic and Health Surveys PLOS ONE.* (2020) 15:e0239754. doi: 10.1371/journal.pone.0239754

17. Jillian O, Kizito O. Socio-Cultural factors associated with incomplete routine immunization of children _ Amach Sub-County, Uganda. *Hsu T-C, editor Cogent Med.* (2020) 7:1848755. doi: 10.1080/2331205X.2020.1848755

18. Kriss JL, Goodson J, Machekanyanga Z, Shibeshi ME, Daniel F, Masresha B, et al. Vaccine receipt and vaccine card availability among children of the apostolic faith: analysis from the 2010-2011 Zimbabwe demographic and health survey. *Pan Afr Med J.* (2016) 24:47. doi: 10.11604/pamj.2016.24.47.8663

19. Malik MN, Awan MS, Saleem T. Social mobilization campaign to tackle immunization hesitancy in Sargodha and Khushab districts of Pakistan. *J Glob Health.* 10. doi: 10.7189/jogh.10.0201302

20. Wong LP, Alias H, Sam I-C, Zimet GD, A. Nationwide study comparing knowledge and beliefs about HPV among female students before and after HPV vaccination. *J Pediatr Adolesc Gynecol.* (2019) 32:158–64. doi: 10.1016/j.jpag.2018.10.010

21. Warner EL, Fowler B, Martel L, Kepka D. Improving HPV vaccination through a diverse multi-state coalition. *J Community Health.* (2017) 42:911–20. doi: 10.1007/s10900-017-0334-7

22. Nancy S, Dongre AR. Behavior change communication: past, present, and future. *Indian J Community Med.* (2021) 46:186–90. doi: 10.4103/ijcm.IJCM_441_20

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Comparative Study on Residents' Health-Promoting Lifestyle and Life Satisfaction in Wuhan Before and After the COVID-19 Pandemic

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The Coronavirus Disease-19 (COVID-19) pandemic has dramatically affected residents' life. Whether the COVID-19 pandemic has significantly influenced the residents' health-promoting lifestyle, and life satisfaction is an urgent problem to be studied. Based on Health Belief Model (HBM), this paper explored and compared the responses of residents' health-promoting lifestyle and life satisfaction on the influence of the COVID-19 pandemic. Data were collected from a sample of 2,054 residents in Wuhan by questionnaire survey. The results show that the total score of health-promoting lifestyle after the COVID-19 pandemic has increased significantly compared with that before the COVID-19 pandemic, and the scores of all dimensions of health-promoting lifestyle have improved. Among them, the scores of exercises, self-actualization, and stress management are significantly higher than those before the COVID-19 pandemic. However, the score of residents' life satisfaction has shown a downward trend. There were also significant differences in life satisfaction on the demographic variables, such as gender, age, education level, marital status, and family average income. The findings are of great significance in promoting residents' health-promoting lifestyles and life satisfaction in the context of the extraordinary pandemic.

Keywords: health-promoting lifestyle, life satisfaction, residents, Wuhan, COVID-19 pandemic

INTRODUCTION

The importance of the health-promoting lifestyle in maintaining personal health has been highlighted (1–4). The concept of a health-promoting lifestyle has been initially put forward by Walker et al. (4), which is also known as healthy behavior. It refers to a multidimensional model of self-initiated actions and perceptions on health, which serve to preserve or enhance people's wellness, self-actualization, and fulfillment. Health-promoting lifestyle mainly contains six dimensions, such as self-actualization, health responsibility, exercise, nutrition, interpersonal support, and stress management (4).

To date, extensive studies have been shown that residents with a health-promoting lifestyle would follow with interest to their health status and disease prevention (1). There is a significant positive correlation between health-promoting lifestyle and residents' physical health, mental health, and social interactions (2). Physiological factors, psychological factors, and cognitive factors have a significant effect on health-promoting lifestyles, such as school education and environment (3), age, physical condition (5), family (6), marital status, education level, income (7), and individual psychology (5, 8, 9).

Moreover, previous studies have identified that people's health-promoting lifestyle would significantly affect the quality of life satisfaction (10). Life satisfaction, which is an essential part of subjective wellbeing, is defined as people's independent judgment and evaluation of their life happiness (11). An unreasonable health-promoting lifestyle would increase the probability of illness and reduce physical and psychological life satisfaction. Carrying out the appropriate intervention programs of health-promoting lifestyle could effectively improve physical, mental health, and life satisfaction (12–14). Individuals with different levels of life satisfaction would also have different health-promoting lifestyles (15). How to keep a healthy lifestyle and high life satisfaction has been a question of great interest.

Nowadays, the emergence of the Coronavirus Disease-2019 (COVID-19) pandemic, which has been defined as a public health emergency, has directly threatened people's health. Although the COVID-19 pandemic has been controlled to some extent, the effect of the COVID-19 pandemic on people has still been persistent. Health has also become a vital problem concerned by countries and people all around the world. Under the background of normalization of international pandemic prevention and control, cultivating healthy lifestyle perceptions, implementing health-promoting lifestyle, and promoting higher life satisfaction need to be concerned and improved constantly.

Wuhan city in China, the outbreak place of the COVID-19 pandemic, is one of the most severely infected cities all over the world. On December 8, 2019, the COVID-19 pandemic was broke out in South China Seafood Market in Wuhan. With the rapid development of the pandemic, on January 23, 2020, Wuhan took the measure of "lockdown". Until April 8, 2020, Wuhan city was "unsealed" and the COVID-19 pandemic was effectively under control. Amid the COVID-19 pandemic, people in Wuhan have deeply experienced and perceived the hazards and preventive measures of the COVID-19 pandemic. Health-promoting activities that are highly related to physical resistance and immunity have become the ardent demands of people (16). People are more eager to cultivate a healthy lifestyle (17). According to the survey of China Education Daily, 78% of people are willing to take exercise and maintain a healthy lifestyle after the COVID-19 pandemic (18). At the same time, Wuhan's medical and healthcare system has been gradually improved, mainly includes increasing financial investment and medical insurance, building a hierarchical medical system, enhancing the ability of grass-roots medical and health services, and improving the community joint prevention and control mechanism (19). Hence, it is convincing to select Wuhan residents as the survey sample to discuss the effect of the COVID-19 pandemic.

This study was built on the Health Belief Model (HBM), which was proposed by Hochbaum in 1958 (20) and improved by Becker and other social psychologists (21). HBM claimed that people's perceptions and behaviors of health would effectively maintain or promote people's health and further influence the achievement of people's self-satisfaction and self-actualization. That is, how people understand the severity and susceptibility of health and disease and how people take actions would directly influence people's self-satisfaction. Existing research studies have already shown that the COVID-19 pandemic

has significantly aroused the people' health consciousness and effectively improved the rationality of people's health perceptions (22). Thus, this study is aimed to explore and compare the responses of people's health-promotion lifestyle and life satisfaction on the influence of the COVID-19 pandemic, that is, whether the people's health-promoting lifestyle and life satisfaction have been impacted by the COVID-19 pandemic. If so, what will happen? This study is expected to make a contribution to a deeper understanding of people's health-promoting lifestyle and life satisfaction in the context of an extraordinary pandemic and also give the theoretical and practical implications for developing and applying HBM. Based on the above discussion, the research hypotheses H1–H4 as follows were put forward.

H1: Residents' health-promoting lifestyle has been significantly influenced by the COVID-19 pandemic;

H2: Residents' life satisfaction has been significantly influenced by the COVID-19 pandemic;

H3: Residents' health-promoting lifestyle and life satisfaction have significant differences in demographic variables under the influence of the COVID-19 pandemic;

H4: Before and after the COVID-19 pandemic, residents' health-promoting lifestyle has a significantly impact on residents' life satisfaction.

METHODS

Data Collection and Procedures

A questionnaire survey was the main survey method of this research. The residents who have resided in Wuhan for at least 1 year from 2019 and experienced the COVID-19 pandemic were selected as the respondents. The stratified convenient sampling method was mainly used to determine samples from 13 municipal districts of Wuhan (there are 13 municipal districts in Wuhan), namely, Hankou District, Hanyang District, Wuchang District, Dongxihu District, Caidian District, and so on. Then selected two communities in each municipal district and 70–100 residents in each community. Residents with cognitive impairment or serious diseases (such as mental illness and Alzheimer's disease) were excluded from the study. The questionnaire was distributed and collected from January to February in 2021 after the epidemic situation had been controlled and the residents had returned to normal life. For this study, the questionnaires were sent to the residents online by a professional survey app (so-jump). If participants have dyslexia, they would be interviewed offline by researchers. In the end, 2,054 valid samples were collected.

Instrumentation

The questionnaire measured the following constructs: demographic survey, health-promoting lifestyle, and life satisfaction. The demographic survey was designed with six items to learn about residents' gender, age, education, marital status, permanent residence, and average family income.

Health-Promoting Lifestyle Profile

The Chinese version of Health-Promoting Lifestyle Profile (HPLP) by Huang (23) was adopted as the survey tool to measure residents' health-promoting lifestyle in this study, which was initially compiled by Walker et al. (4). The scale includes six dimensions and 42 items, namely, self-actualization (14 items), health responsibility (nine items), stress management (six items), interpersonal support (five items), nutrition (five items), and exercise (three items) (23). The survey utilized the four-point Likert scale from one (never) to four (routinely). A higher score of HPLP indicates a more excellent health-promoting lifestyle. The original Chinese version of HPLP by Huang has good reliability, in which the Cronbach's alpha of the scale was 0.930 and the Cronbach's alpha of the subscales was from 0.736 to 0.922 (23). In this research, the Cronbach's alpha was 0.922, which also shows good reliability.

Satisfaction With Life Scale

The Satisfaction with Life Scale (SWLS) as the survey tool to measure residents' life satisfaction was adopted in this study, which was initially compiled by Diener et al. (24). Five items were designed, i.e., "*In most ways, my life is close to my ideal*", "*The conditions of my life are excellent*", "*I am satisfied with my life*", "*So far I have gotten the important things I want in life*", and "*If I could live my life over, I would change almost nothing*" (24). The survey was utilized the seven-point Likert scale from one (strongly disagree) to seven (strongly agree). The original SWLS has a good reliability with the Cronbach's alpha of 0.870. In this research, the Cronbach's alpha was 0.813 with a good reliability.

Data Analysis

EpiData was used to input and check the data. Data analysis was conducted by Stata 16.0. The respondents' demographic situation was statistically calculated by means, SD, and percentages. Paired groups were compared by paired sample t-test and one-way ANOVA. Person correlation analysis was used to measure the correlation between health-promoting lifestyle and life satisfaction. The significance level for all statistical analyses was set at $p < 0.05$ (two-tailed test). Multiple regression analyses were performed to explore the relative contribution of each significant variable. Health-promoting lifestyle and demographic variables were set as independent variables, and life satisfaction was set as dependent variables.

RESULTS

General Characteristics

Of the total 2,200 anonymous questionnaires, 2,080 were returned and the response rate was 94.5%. In total, 26 invalid questionnaires were rejected due to the incomplete information, and 2,054 questionnaires were effective and the effective rate was 93.4%.

Table 1 shows the demographic characteristics of the survey samples. The proportion of men and women participating in the survey is balanced, with men for 49.1% and women for 50.9%. The proportion of each group's age is relatively balanced, and most of them have a high school diploma or higher, accounting

TABLE 1 | General characteristics of participants ($N = 2,054$).

Variable	N (%)	M ± SD
Gender		
Men	1,009 (49.1%)	1.51 ± 0.50
Women	1,045 (50.1%)	
Age		
18 and below	398 (19.4%)	3.06 ± 1.66
19–30	374 (18.2%)	
31–40	349 (17.0%)	
41–50	301 (14.7%)	
51–60	363 (17.7%)	
61 and above	269 (13.1%)	
Education		
Elementary school or less	155 (7.5%)	3.27 ± 1.04
Middle school	291 (14.2%)	
High school	706 (34.4%)	
Post-secondary school and above	902 (43.9%)	
Marital status		
Discoverture	1,070 (52.1%)	1.56 ± 0.66
Married	853 (41.5%)	
Divorced	100 (4.9%)	
Widowed	31 (1.5%)	
Permanent residence		
Urban	1,110 (54.0%)	1.31 ± 0.46
Rural	944 (46.0%)	
Average family income		
10,000 and below	376 (18.3%)	4.43 ± 2.22
10,001–20,000	221 (10.8%)	
20,001–30,000	109 (5.3%)	
30,001–40,000	95 (4.6%)	
40,001–50,000	392 (19.1%)	
50,001–60,000	403 (19.6%)	
60,001 and above	458 (22.3%)	

N stands for the sample size; M stands for mean (the average value); SD stands for standard deviation. Average family income (RMB).

for 79.3%. Unmarried and married groups are the main groups in the total sample. As far as permanent residence is concerned, the number of residents living in urban areas is slightly more than in the suburbs. The average family income is mostly beyond 40,000 RMB (see **Table 1**).

Comparison of Health-Promoting Lifestyle and Life Satisfaction Before and After the COVID-19 Pandemic

Table 2 shows the changes in residents' health-promoting lifestyle and life satisfaction scores before and after the COVID-19 pandemic. The results show that health-promoting lifestyle [$t = -3.67$, $p < 0.001$] and life satisfaction [$t = -2.57$, $p < 0.01$] have changed significantly after the COVID-19 pandemic but the score of life satisfaction has shown a downward trend. The score of health-promoting lifestyle before the COVID-19 pandemic was [107.35 ± 24.08] and after was [108.16 ± 24.10]

TABLE 2 | Comparison of Health-Promoting Lifestyle Profile (HPLP) and Satisfaction with Life Scale (SWLS) before and after the COVID-19 pandemic (N = 2,054).

Variable	M ± SD		t and P
	Before	**After**	
HPLP	107.35 ± 24.08	108.16 ± 24.10	−3.67***
Health responsibility	17.62 ± 5.06	17.89 ± 4.98	−0.26
Exercise	12.73 ± 3.81	12.80 ± 3.73	−3.77***
Nutrition	18.13 ± 4.70	18.33 ± 4.73	−1.22
Self-actualization	19.09 ± 6.67	19.11 ± 4.70	−3.05**
Interpersonal support	21.44 ± 5.35	21.55 ± 5.41	−1.52
Stress management	18.34 ± 4.71	18.49 ± 4.70	−2.42*
SWLS	21.12 ± 6.53	20.87 ± 6.60	2.57**

*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.
M stands for mean (the average value); SD stands for standard deviation.

relatively. The score of life satisfaction before and after the COVID-19 pandemic was [21.12 ± 6.53] and [20.87 ± 6.60] relatively. Hypotheses 1 and 2 were verified.

Among the six dimensions of health-promoting lifestyle, it can be seen that the scores of exercise [$t = −3.77$, $p < 0.001$], self-actualization [$t = −3.05$, $p < 0.001$], and stress management [$t = −2.42$, $p < 0.05$] have increased significantly after the COVID-19 pandemic. The score of exercise before the COVID-19 pandemic was [12.73 ± 3.81] and after the COVID-19 pandemic was [12.80 ± 3.73]. The score of self-actualization before the COVID-19 pandemic was [19.09 ± 6.67] and after the COVID-19 pandemic was [19.11 ± 4.70]. The score of stress management before the COVID-19 pandemic was [19.09 ± 6.67] and after the COVID-19 pandemic was [19.11 ± 4.70]. The scores of health responsibility, nutrition, and interpersonal support have increased but not significantly after the COVID-19 pandemic. The score of health responsibility before the COVID-19 pandemic was [17.62 ± 5.06] and after the COVID-19 pandemic was [17.89 ± 4.98]. The score of nutrition before the COVID-19 pandemic was [18.13 ± 4.70] and after the COVID-19 pandemic was [18.33 ± 4.73]. The score of interpersonal support before the COVID-19 pandemic was [21.44 ± 5.35] and after the COVID-19 pandemic was [21.55 ± 5.41] (see **Table 2**).

Comparison of HPLP and SWLS With General Characteristics Before and After the COVID-19 Pandemic

Table 3 shows the differences in residents' life satisfaction and health-promoting lifestyle in the different demographic variables before and after the COVID-19 pandemic.

In terms of life satisfaction, before and after the COVID-19 pandemic, there were significant differences in the aspect of gender [$t_{before} = −1.99$, $p_{before} < 0.05$; $t_{after} = 1.82$, $p_{after} < 0.05$], age [$t_{before} = 11.27$, $p_{before} < 0.001$; $t_{after} = 3.91$, $p_{after} < 0.01$], education level [$t_{before} = 5.44$, $p_{before} < 0.01$; $t_{after} = 3.39$, $p_{after} < 0.01$], marital status [$t_{before} = 10.21$, p_{before}

< 0.001; $t_{after} = 3.51$, $p_{after} < 0.05$], and average family income [$t_{before} = 9.77$, $p_{before} < 0.001$; $t_{after} = 5.24$, $p_{after} < 0.001$]. The individuals with the characteristics of men, younger age, higher education, unmarried, and middle average family income have significantly higher life satisfaction before and after the COVID-19 pandemic.

In terms of health-promoting lifestyle, before the COVID-19 pandemic, there were significant differences in terms of age [$t_{before} = 3.26$, $p_{before} < 0.01$], education level [$t_{before} = 2.91$, $p_{before} < 0.05$], and average family income [$t_{before} = 3.01$, $p_{before} < 0.01$]. After the COVID-19 pandemic, there were significant differences in health-promoting lifestyle scores in terms of age [$t_{after} = 2.67$, $p_{after} < 0.05$] and education level [$t_{after} = 2.58$, $p_{after} < 0.05$], but the average family income became less significant (see **Table 3**). Hypothesis 3 was partially verified.

Correlations Between Health-Promoting Lifestyle and Life Satisfaction

Table 4 shows the correlation between health-promoting lifestyle and life satisfaction before and after the COVID-19 pandemic. The result shows that a health-promoting lifestyle is positively correlated with life satisfaction before and after the COVID-19 pandemic. The correlation coefficient between health-promoting lifestyle and life satisfaction is 0.33. All the six dimensions of a health-promoting lifestyle are positively correlated with life satisfaction before and after the COVID-19 pandemic. Before the COVID-19 pandemic, the correlation coefficients between life satisfaction and the six dimensions of self-actualization, health responsibility, exercise, nutrition, interpersonal support, and stress management are 0.37, 0.23, 0.21, 0.26, 0.31, and 0.28, respectively. After the COVID-19 pandemic, the correlation coefficients between life satisfaction and the six dimensions of self-actualization, health responsibility, exercise, nutrition, interpersonal support, and stress management are 0.35, 0.24, 0.22, 0.26, 0.30, and 0.30, respectively (see **Table 4**).

Analysis of Influencing Factors of Life Satisfaction Before and After the COVID-19 Pandemic

Table 5 shows the results of multiple regression analysis on life satisfaction before and after the COVID-19 pandemic. The statistically significant demographic variables and the scores of each dimension of health-promoting lifestyle were used as independent variables, and the total score of life satisfaction was used as the dependent variable to perform multiple linear regression analysis. The results show that the health-promoting lifestyle, age, marital status, average family income, permanent residence, and self-actualization have a significant impact on life satisfaction before the COVID-19 pandemic and the explanation for the total variation in life satisfaction is 16.1% (overall model adjust $R^2 = 0.16$, $p < 0.001$). After the COVID-19 pandemic, the health-promoting lifestyle, age, marital status, average family income, permanent residence, self-actualization, and stress management have a significant impact on life satisfaction. The explanation for the total variation in life

TABLE 3 | Comparison of HPLP and SWLS with general characteristics before and after the COVID-19 pandemic ($N = 2,054$).

Variable	SWLS		t(F) and p		HPLP		t(F) and p	
	Before	After	Before	After	Before	After	Before	After
Gender								
Men	21.26 ± 6.87	21.02 ± 7.01	−1.99*	1.82*	107.17 ± 22.350	107.31 ± 22.46	−0.34	−1.58
Women	20.83 ± 5.70	20.53 ± 5.56			107.53 ± 25.643	108.99 ± 25.56		
Age								
18 and below	23.08 ± 6.81	22.07 ± 7.11	11.27***	3.91**	108.96 ± 26.93	109.88 ± 26.42	3.26**	2.67*
19–30	21.50 ± 6.37	21.02 ± 6.50			107.07 ± 23.47	108.48 ± 23.96		
31–40	20.84 ± 6.01	20.95 ± 6.05			108.86 ± 22.80	109.03 ± 22.08		
41–50	20.44 ± 6.39	20.54 ± 6.37			105.54 ± 24.12	107.19 ± 23.65		
50–60	19.47 ± 7.64	19.92 ± 7.86			103.24 ± 17.56	103.54 ± 17.87		
61 and above	20.14 ± 5.28	20.17 ± 5.12			110.69 ± 28.11	109.91 ± 28.12		
Education								
Elementary school or less	20.77 ± 6.43	20.89 ± 5.92	5.44**	3.39**	111.40 ± 27.44	110.81 ± 27.17	2.91*	2.58*
Middle school	20.29 ± 6.80	20.37 ± 6.73			104.15 ± 24.40	105.22 ± 23.88		
High school	20.61 ± 6.64	20.45 ± 6.88			106.82 ± 23.08	107.63 ± 22.75		
Undergraduate	21.56 ± 6.42	21.04 ± 6.51			107.64 ± 24.02	108.64 ± 24.20		
Master degree or above	22.67 ± 5.92	22.44 ± 6.04			109.82 ± 23.46	111.15 ± 24.44		
Marital status								
Discoverture	21.86 ± 6.38	21.25 ± 6.48	10.21***	3.51*	107.43 ± 24.36	108.59 ± 24.58	0.08	0.96
Married	20.22 ± 6.59	20.32 ± 6.69			107.31 ± 23.06	108.02 ± 22.72		
Divorced	21.04 ± 6.83	21.53 ± 6.73			106.48 ± 23.06	104.42 ± 23.45		
Widowed	20.81 ± 6.51	20.65 ± 6.65			108.71 ± 40.92	109.52 ± 40.77		
Permanent residence								
Urban	21.26 ± 6.88	21.02 ± 7.01	1.47	1.70	106.82 ± 22.64	107.76 ± 22.79	−1.40	−1.05
Rural	20.83 ± 5.70	20.53 ± 5.56			108.53 ± 26.93	109.04 ± 26.73		
Average family income								
10,000 and below	22.15 ± 6.93	21.55 ± 7.13	9.77***	5.24***	104.92 ± 25.55	106.41 ± 25.29	3.01**	0.82
10,001–20,000	21.79 ± 5.91	21.87 ± 5.68			102.95 ± 21.42	106.28 ± 21.64		
20,001–30,000	23.40 ± 5.28	22.20 ± 5.75			106.48 ± 18.71	108.84 ± 19.76		
30,001–40,000		22.51 ± 6.60			106.54 ± 23.58	108.02 ± 22.81		
40,001–50,000		20.17 ± 6.10			108.45 ± 23.17	108.89 ± 22.95		
50,001–60,000		20.11 ± 6.61			108.78 ± 23.17	108.88 ± 23.28		
60,001 and above		20.43 ± 6.94			109.66 ± 26.39	109.13 ± 26.92		

*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.
HPLP, Health-Promoting Lifestyle Profile; SWLS, Satisfaction with Life Scale; Average family income (RMB).

satisfaction is 14% (overall model adjust $R^2 = 0.14$, $p < 0.001$; see **Table 5**). Hypothesis 4 was verified.

DISCUSSION

This study has investigated the relationship between health-promoting lifestyle and life satisfaction before and after the COVID-19 pandemic. The result has shown that after the outbreak of the COVID-19 pandemic, the residents' total score and the scores of all dimensions of health-promoting lifestyle are higher than those before the pandemic. This is consistent with the existing findings (25). That is, after the outbreak of the COVID-19 pandemic, people are paying more attention to the multidimensional pattern of self-initiated actions and perceptions, such as health responsibility, exercise, nutrition,

self-actualization, interpersonal support, and stress management. The government and non-governmental organizations have formulated corresponding plans and issued relevant policies to increase the opportunities for residents to participate in physical exercise and develop a healthy lifestyle. The government of Wuhan has issued the *Home scientific fitness guide*, which updates the new standards of residents' physical practice and increases the types of indoor physical activities (such as yoga and aerobics) to provide scientific guidance (26). In addition to the government, some technology companies have launched the "Internet + sports" model and fitness apps, such as "Keep". These fitness apps have successively set up the modules, such as "Online marathon" or "Online training camp", to encourage residents to participate indoors (27). Communities have actively organized activities to encourage residents to participate in

TABLE 4 | Correlations between health-promoting lifestyle and life satisfaction ($N = 2{,}054$).

	Variables	1	2	3	4	5	6	7	8
Before	1.SWLS	1							
	2.Self-actualization	0.37**	1						
	3.Health responsibility	0.23**	0.62**	1					
	4.Exercise	0.21**	0.60**	0.71**	1				
	5.Nutrition	0.26**	0.62**	0.70**	0.70**	1			
	6.Interpersonal support	0.31**	0.71**	0.64**	0.62**	0.66**	1		
	7.Stress management	0.28**	0.67**	0.67**	0.65**	0.70**	0.75**	1	
	8.HPLP	0.33**	0.83**	0.85**	0.82**	0.86**	0.87**	0.87**	1
After	1.SWLS	1							
	2.Self-actualization	0.35**	1						
	3.Health responsibility	0.24**	0.61**	1					
	4.Exercise	0.22**	0.60**	0.69**	1				
	5.Nutrition	0.26**	0.64**	0.67**	0.70**	1			
	6.Interpersonal support	0.30**	0.71**	0.65**	0.65**	0.69**	1		
	7.Stress management	0.30**	0.66**	0.66**	0.67**	0.71**	0.74**	1	
	8.HPLP	0.33**	0.82**	0.84**	0.83**	0.86**	0.88**	0.87**	1

*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.
HPLP, Health-Promoting Lifestyle Profile; SWLS, Satisfaction with Life Scale.

TABLE 5 | Analysis of influencing factors of life satisfaction before and after the COVID-19 pandemic.

	Independent variables	Unstandardized		Standardized	
		B	SE	β	t(F) and p
Before	HPLP	0.09	0.01	0.33	15.63***
	Age	−0.51	0.13	−0.13	−4.03***
	Marital status	0.65	0.30	0.07	2.17*
	Average family income	−0.31	0.07	−0.11	−4.57***
	Permanent residence	−0.61	0.29	−0.04	−2.11*
	Self-actualization	0.41	0.04	0.30	9.42***
After	HPLP	0.10	0.02	0.33	15.63***
	Age	−0.31	0.13	−0.08	−2.38***
	Marital status	0.86	0.31	0.09	2.80***
	Average family income	−0.28	0.07	−0.09	−4.10***
	Permanent residence	−0.66	0.30	0.05	−2.21*
	Self-actualization	0.36	0.04	0.25	8.08***
	Stress management	0.15	0.05	0.11	3.04***

Over Model $R^2 = 0.166$; adjust $R^2 = 0.16$ (before the COVID-19 pandemic).
Over Model $R^2 = 0.145$; adjust $R^2 = 0.14$ (after the COVID-19 pandemic).
*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.
Independent variables, health-promoting lifestyle; Dependent variables, life satisfaction; HPLP, Health-Promoting Lifestyle Profile.

physical exercise, such as community marathons, fun sports meetings, and health promotion meetings (28). According to the HBM, this may be closely related to the change of positive attitude toward health (29). The consciousness and attitude of how people treat health and disease would directly influence people's healthy actions, further influencing self-satisfaction. This is also consistent with the viewpoint of emphasizing the importance of

psycho-physic-mental continuity for overall health (30). After deep experiencing and perceiving the COVID-19 pandemic, residents' consciousness and perceptions of disease and health would be significantly improved and further promote the health-promoting lifestyle.

The result has shown that residents' life satisfaction score after the COVID-19 pandemic was lower than that before

the pandemic. This is consistent with the existing research (31). This could be caused by the diffusion of the COVID-19 pandemic, which not only produces an effect on the change of anxiousness of physical health, but also increases the psychological pressure. To some extent, pressure and anxiety will reduce life satisfaction (32).

Besides, based on the HBM, people's demographic characteristics would directly influence people's health-promoting lifestyle and life satisfaction. The results of this study have also shown that age, marital status, and average family income have a significant impact on residents' life satisfaction. Age and education level have a significant effect on residents' health-promoting lifestyle. This keeps pace with the previous studies (33).

In addition, the results of multiple linear regression show that the health-promoting lifestyle is an influencing factor on life satisfaction whether before or after the COVID-19 pandemic. Especially, self-actualization and stress management have a significant positive influence on life satisfaction. This study has identified self-actualization as an important influencing factor on life satisfaction, which is inconsistent with the research results of Sak et al. (13). The reason may be that individuals with higher self-actualization have stronger psychological endurance, which is not easily affected by anxiety and fear. For the panic caused by COVID-19, these groups will usually maintain an optimistic attitude, be good at adjusting their emotions, and give positive psychological hints for themselves. Stress management has been proved as a vital influencing factor on residents' life satisfaction, which is consistent with Yang's research results (34). Studies have shown that improving one's ability to withstand stress could deal with more external challenges and enhance self-efficacy to face difficulties actively (35).

CONCLUSION

This study mainly explores and analyzes the changes in health-promoting lifestyle and life satisfaction and the essential predictors that affect life satisfaction before and after the COVID-19 pandemic. It also demonstrates the relationship between health-promoting lifestyle and life satisfaction. These findings have suggested that the health-promoting lifestyle has been impacted significantly by the COVID-19 pandemic. In addition, the health-promoting lifestyle has improved after the pandemic, but the score of life satisfaction has shown a downward trend. Before and after the COVID-19 pandemic, the health-promoting lifestyle has a significant impact on residents' life satisfaction.

In response to the impact of the COVID-19 pandemic, on September 16, 2020, the United Nations has released *The United Nations Comprehensive Response to the COVID-19 Report* (36).

REFERENCES

1. Liu YB, Liu L, Li YF, Chen YL. Relationship between health literacy, health-related behaviors and health status: a survey of elderly Chinese. *Int J Environ Res Public Health.* (2015) 12:9714–25. doi: 10.3390/ijerph120809714

It has advocated that governments and health organizations of all countries should play a leading role in global health countermeasures, fully mobilize every family to cultivate health awareness, help people form a healthy lifestyle, and cultivate more healthy behaviors. Therefore, a variety of measures should be taken to promote a health-promoting lifestyle in the post-pandemic period. Such as promoting health publicity through various channels; strengthening health education in terms of self-actualization, health responsibility, exercise, nutrition, interpersonal support, and stress management to establish the correct concept of health; promoting the quality of health-related social services, and carrying out more health-related activities to increase residents' enthusiasm and chances to improve healthy lifestyle; strengthening psychological guidance and improving psychological endurance to enhance the stress management ability and help residents improve their life satisfaction.

This study has the following limitations. The survey sample is restricted to the city of Wuhan. Although the city of Wuhan has the typical representativeness, it does not have general applicability. Follow-up research can further expand the scope of the investigation and select regions with different pandemic levels for comparative analysis. In addition, a deeper investigation of residents' perceptions and behaviors will be conducted in a follow-up study.

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 questionnaire data were collected anonymously in this study, and questionnaire filling was voluntary. The subjects were promised that the questionnaire data would only be used for academic research and kept strictly confidential. The participants have provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

DK: data analysis and reporting and manuscripts. WC: reviewing and editing and supervision. Both authors contributed to the article and approved the submitted version.

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2. Umberson D, Crosnoe R, Reczek C. Social relationships and health behavior across the life course. In: Cook KS, Massey DS, editors. *Annu Rev Sociol.* (2010) 36:139–57. doi: 10.1146/annurev-soc-070308-120011

3. Ural A, Beji NK. The effect of health-promoting lifestyle education program provided to women with gestational diabetes mellitus on maternal and

neonatal health: a randomized controlled trial. *Psychol Health Med.* (2020) 26:657–70. doi: 10.1080/13548506.2020.1856390

4. Walker SN, Sechrist KR, Pender NJJ. The health-promoting lifestyle profile: development and psychometric characteristics. *Nurs Res.* (1987) 36:76–81. doi: 10.1097/00006199-198703000-00002

5. Ellis KR, Janevic MR, Kershaw T, Caldwell CH, Janz NK, Northouse L. Engagement in health-promoting behaviors and patient-caregiver interdependence in dyads facing advanced cancer: an exploratory study. *J Behav Med.* (2017) 40:506–19. doi: 10.1007/s10865-016-9819-6

6. Kim ON, Oh JW, Kim YS, Kim HW, Lee MY, Ha SHJ. Impacts of perceived health status and self-efficacy in hospital nurses on their health promoting behaviors. *AISS.* (2014) 37:46–54. doi: 10.1177/216507990104900204

7. Chen L, Jing Z, Wei F. Health-promoting lifestyles and their related influences among nursing assistants in nursing homes in China. *Appl Nurs Res.* (2018) 39:97–102. doi: 10.1016/j.apnr.2017.11.009

8. Dehjan Z, Mahmoodi M, Javadzade H, Reisi M. Comparison of health promoting lifestyle predictors in high school students with and without overweight and obesity: an application of health promotion model. *Int J Pediatr-Masshad.* (2020) 8:11297–309. doi: 10.22038/ijp.2020.48430.3898

9. Yang S, Park S, Kim HJ. Effects of depression, expectations regarding aging on the health promoting lifestyle among health checkup examinee. *J. Korea Contents Association.* (2018) 18:509–19. doi: 10.5392/JKCA.2018.18.02.509

10. Heidari M. Relationship of lifestyle with academic achievement in nursing students. *JCDR.* (2017) 11:JC1–3. doi: 10.7860/JCDR/2017/24536.9501

11. Diener E. Subjective well-being. *Psychol Bull.* (1984) 95:542–75. doi: 10.1037/0033-2909.95.3.542

12. Huang HC, Lin KC, Wu CS, Miao NF, Chen MY. Health-promoting behaviors benefit the mental health of cirrhotic outpatients. *Qual Life Res.* (2018) 27:1521–32. doi: 10.1007/s11136-018-1818-3

13. Sak J, Sagan D, Wiechetek M, Pawlikowski J. Suboptimal perception of illness due to self-realization constraints impairs psychological welfare in surgical patients(dagger). *Eur J Cardio-Thorac Surg.* (2012) 41:824–8. doi: 10.1093/ejcts/ezr134

14. Sok SR, Cheon BK, Gu MK, Kim OS. Comparisons of health promoting behavior, depression, and life satisfaction between older adults in rural areas in South Korea living in group homes and at home. *J Nurs Res.* (2019) 27:11. doi: 10.1097/JNR.0000000000000290

15. Phulkerd S, Thapsuwan S, Chamratrithirong A, Gray RS. Influence of healthy lifestyle behaviors on life satisfaction in the aging population of Thailand: a national population-based survey. *BMC Public Health.* (2021) 21:10. doi: 10.1186/s12889-020-10032-9

16. Zhong B, Huang YK, Liu Q. Mental health toll from the coronavirus: social media usage reveals Wuhan residents' depression and secondary trauma in the COVID-19 outbreak. *Comput Hum Behav.* (2021) 114:10. doi: 10.1016/j.chb.2020.106524

17. Scudiero O, Lombardo B, Brancaccio M, Mennitti C, Frisso G, Health P. Exercise, immune system, nutrition, respiratory and cardiovascular diseases during COVID-19: a complex combination. *Int J Environ Res.* (2021) 18:904. doi: 10.3390/ijerph18030904

18. Gu Ning, Feng Lei. Fitness trends during the anti-epidemic period. *China Sports News.* (2020). Available online at: http://sports.people.com.cn/GB/31928/412458/ (accessed December 20, 2021).

19. Yin GF, Song HN, Wang J, Nicholas S, Maitland E. The COVID-19 run on medical resources in Wuhan China: causes, consequences and lessons. *Healthcare.* (2021) 9:14. doi: 10.3390/healthcare9101362

20. Hochbaum G. Health belief model. *Nursing.* (2000) 15:175–83. doi: 10.1177/109019818801500203

21. Becker MH, Maiman LA, Kirscht JP, Haefner DP, Drachman RH. The health belief model and prediction of dietary compliance: a field experiment. *J Health Soc Behav.* (1977) 18:348–66. doi: 10.2307/2955344

22. Niu Z, Li L, Li H, Mei S, Jiang H, Deng Z, et al. Latent profile analysis of perceptions and attitudes towards COVID-19 in a sample of chinese people. *Front Public Health.* (2021) 9:727242. doi: 10.3389/fpubh.2021.727242

23. Huang YH. Assessment of the health-promoting lifestyle profile on reliability and validity. *Kaohsiung J Med Sci.* (1996) 12:529.

24. Diener E, Emmons RA, Larsen RJ, Griffin S. The satisfaction with life scale. *Pers Assess.* (1985) 49:71–5. doi: 10.1207/s15327752jpa4901_13

25. Musche V, Bauerle A, Steinbach J, Schweda A, Hetkamp M, Weismuller B, et al. COVID-19-related fear and health-related safety behavior in oncological patients. *Front Psychol.* (2020) 11:8. doi: 10.3389/fpsyg.2020.01984

26. Wuhan Sport Bureau. Home scientific fitness guide (2020). Available online at: https://m.gmw.cn/baijia/2020-04/21/1301168163.html (accessed December 20, 2021).

27. China National Sports General Administration. *The Epidemic Brings New Opportunities and Will Vigorously Develop Internet + Sports.* (2020). Available online at: https://baijiahao.baidu.com/s?id=1659587989723932227&wfr=spider&for=pc (accessed December 21, 2021).

28. Wuhan Municipal Government. 2020 Wuhan National Fitness Games (2020). Available online at: https://baijiahao.baidu.com/s?id=1674430793758007690&wfr=spider&for=pc (accessed December 20, 2021).

29. Espinosa A, Kadic-Maglajlic S. The mediating role of health consciousness in the relation between emotional intelligence and health behaviors. *Front Psychol.* (2018) 9:11. doi: 10.3389/fpsyg.2018.02161

30. Achilie-Valencia T, Rodriguez-Zambrano A, Villafuerte-Holguin J. Investigative role in the identity of teachers of physical education and educational psychology: comparative study. *Retos.* (2022) 43:192–204. doi: 10.47197/retos.v43i0.88642

31. Kumar P, Kumar N, Aggarwal P, Yeap JAL. Working in lockdown: the relationship between COVID-19 induced work stressors, job performance, distress, and life satisfaction. *Curr Psychol.* 16:6308–23. doi: 10.1007/s12144-021-01567-0

32. Brdovcak B, Merkas M, Sakic Velic M. The role of hope and self-esteem in the relation between economic pressure and life satisfaction of adolescents. *Drus Istraz.* (2018) 27:87–108. doi: 10.5559/di.27.1.05

33. Joshanloo M, Jovanovic V. Similarities and differences in predictors of life satisfaction across age groups: a 150-country study. *J Health Psychol.* (2021) 26:401–11. doi: 10.1177/1359105318819054

34. Yang JD, Guo J, Tang YJ, Huang LL, Wiley J, Zhou ZG, et al. The mediating effect of coping styles and self-efficacy between perceived stress and satisfaction with QOL in Chinese adolescents with type 1 diabetes. *J Adv Nurs.* (2019) 75:1439–49. doi: 10.1111/jan.13933

35. Engin DM. The relationships among coping with stress, life satisfaction, decision-making styles and decision self-esteem: an investigation with Turkish university students. *Soc Behav Pers.* (2006) 34:1161–70. doi: 10.2224/sbp.2006.34.9.1161

36. *The United Nations Comprehensive Response to the COVID-19 Report.* UN (2020). Available online at: https://www.un.org/zh/coronavirus/UN-Plan-to-save-lives-protect-societies-and-recover-better (accessed December 21, 2021).

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Post-acute Sequelae of SARS-CoV-2 Infection: A Neglected Public Health Issue

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INTRODUCTION

The COVID-19 pandemic has caused at least 508,827,830 infections and is associated with a 1.2% mortality rate worldwide (1). New SARS-CoV-2 variants have driven new waves of the pandemic as a result of their increased transmissibility and ability to evade the immune response (2). The post-acute sequelae of SARS-CoV-2 infection (PASC) is an important but underestimated public health issue that can have a long-term impact on pulmonary and multiple extrapulmonary tissues and organs through several potential mechanisms (3, 4). Recent studies demonstrate that approximately 4–69% of patients (including children, adolescents, adults, and senior) suffer from PASC (5–11). There is considerable evidence concerning post-acute sequelae that will likely outlast the current pandemic and need to be addressed. This article reviews the clinical sequelae of COVID-19 survivors and provides valuable insights required to fill the gaps in medical knowledge.

PULMONARY AND EXTRAPULMONARY ORGAN SEQUELAE

There are several persistent sequelae occurring among COVID-19 survivors (see **Figure 1**). A longitudinal cohort study from Wuhan, China found that 1 year after COVID-19 diagnosis, 26% (313/1,185) and 30% (380/1,271) of survivors experienced dyspnea, or persistent breathlessness, at 6 and 12 months, respectively (12). The same study found that lung diffusion impairment was common among critically ill patients at 12 months (12). In a multicenter UK study, Evans et al. (13) found that of 1,077 hospitalized patients, 41% experienced dyspnea and 21–28% experienced palpitations and chest pain 5.9 months after discharge. A random-effect meta-analysis of 257,348 patients revealed that 25, 21, and 31% of survivors displayed persistent dyspnea at 6–8, 9–12, and >12 months follow-up, respectively (14).

There is an increased long-term risk of cardiovascular complications such as heart failure among patients with SARS-CoV-2 infection, even among mild cases (15). A large-scale study including a cohort of 153,760 COVID-19 survivors, an age-matched control group of 5,637,647 individuals, and a historical comparison group of 5,859,411 individuals, was conducted by Al-Aly et al. (16) to estimate the risk of cardiovascular sequelae. COVID-19 survivors had a significantly increased risk of cardiovascular disease within 1 year, including a 52% and a 72% increased risk of stroke and heart failure, respectively (16). SARS-CoV-2 infection is correlated with "new-onset" cardiovascular disease following infection (17). Rizvi et al. (18) independently reported that SARS-CoV-2-infected golden Syrian hamsters had cardiovascular complications such as ventricular wall thickening and interstitial fibrosis with elevated cardiac troponin I during the late phase of infection.

FIGURE 1 | Multiple organ sequelae of SARS-CoV-2 infection.
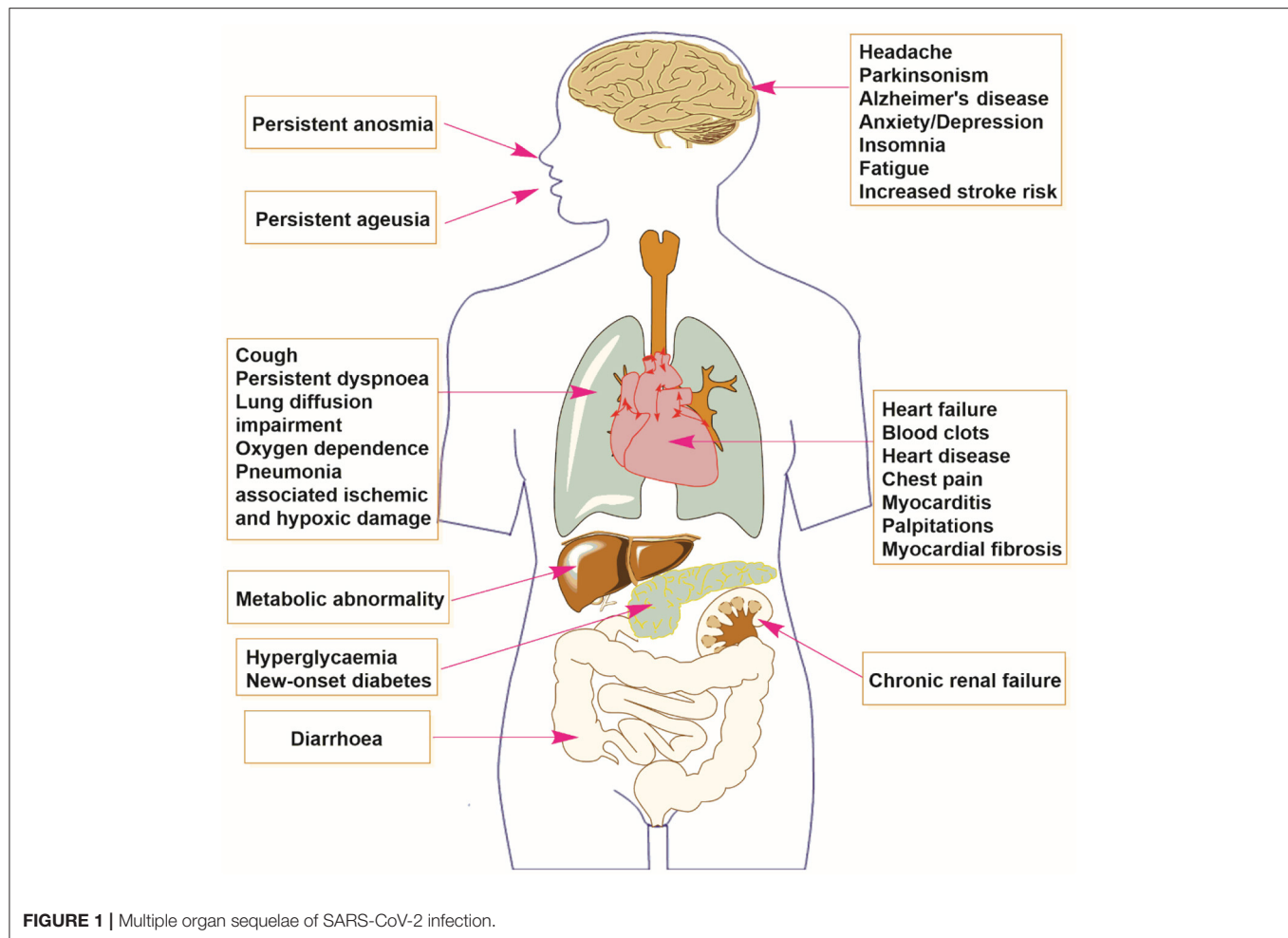
Maio et al. (19) reported that the risk of thromboembolic events 8.5 months after the follow-up of COVID survivors (1.53%, $n = 6,937$) was five times higher than among population controls (0.31%, $n = 435,104$). An online survey showed that 53 and 68% of patients reported chest pain and palpitations 7 months after COVID-19 infection (20).

SARS-CoV-2 infection even among those with mild symptoms can cause severe cognitive and neurological defects (21). Recent studies have demonstrated that >10% of patients experience COVID-19-associated anosmia (21). A large UK-based community cohort study with 4,999 participants conducted from June 2021 to January 2022 found that patients infected with the omicron variant more frequently possessed a loss of smell than those infected with the delta variant (52.7 vs. 16.7%, respectively; $p < 0.001$) (22). Zazhytska et al. (23) found non-cell-autonomous disruption of olfactory sensory neuron nuclear architecture and down-regulation of olfactory receptors and signaling genes in SARS-CoV-2-infected hamster and human autopsies. These findings provide a potential pathophysiological mechanism linking COVID-19 and anosmia. Kraus et al. (24) provided an alternate mechanism by which the intranasal receptor-binding domain of SARS-CoV-2 spike protein causes

olfactory receptor damage and olfactory system dysfunction in SARS-CoV-2-infected zebrafish. This finding has potential implications for the intranasal treatment of PASC. Douaud et al. (25) conducted a large-scale longitudinal neuroimaging cohort study of the brain images from 401 COVID-19 cases 51 to 81 years of age and 384 age-matched controls to estimate how changes to brain structure and function correlate with the taste and smell of infected patients. COVID-19 survivors showed a greater reduction in the gray matter thickness of the parahippocampal gyrus and entorhinal cortex, ranging from ~0.2 to ~2%, and a greater reduction in the global brain volume than controls (25).

To date, from anosmia, headaches, to Parkinsonism, Alzheimer's have been attributed to SARS-CoV-2 infection (26). A clinical study indicated that the risk of dementia was 2–3-fold higher among SARS-CoV-2-infected individuals than healthy controls (27). Semerdzhiev et al. (28) found that Parkinsonism is caused by a direct interaction between the SARS-CoV-2 N-protein and α-synuclein. Lang et al. (29) indicated that hypoxemia, or respiratory compromise, along with potential virus-specific endothelial mechanisms may account for post-infectious Parkinsonism. Revere et al. (30) found that Alzheimer's

is associated with a higher expression of Angiotensin-Converting Enzyme 2 in the brains of COVID-19 survivors, and Shen et al. (31) showed that SARS-CoV-2 enters the brain, induces an Alzheimer's-like gene program in healthy neurons and exacerbates disease-related neuropathology. Fernández-de-las-Peñas et al. (32) found that 8.4–15% of COVID-19 survivors suffer from post-COVID headaches 6 months after infection.

"Long COVID" can cause metabolic abnormalities and immunological dysfunction (33–35). For example, in a cohort study of 551 discharged COVID-19 survivors in Italy, 35 and 2% had hyperglycemia and "new-onset diabetes," respectively, after 6 months (33). In another retrospective England-based cohort study of 47,780 COVID-19 patients with a mean of 65 years of age, 2.9% had "new-onset diabetes" 4.6 months following infection (34). Thus, SARS-CoV-2 infection can cause multiple organ failure and induce long-lasting post-COVID sequelae that are of great concern.

DISCUSSION

The COVID-19 pandemic is ongoing and promising curative treatments do not yet exist (36, 37). Meanwhile, the sequelae of this infection have posed a considerable threat to global health and economic development. Considering the available evidence, additional preventive and treatment strategies are needed.

Current prophylactic measures, such as wearing masks and increasing vaccination coverage, are still necessary. Vaccination is associated with a lower risk of several COVID-19 sequelae and remains the most practical approach to preventing the further spread of the virus (38). After 2 years, 11,438,720,838 doses of the COVID-19 vaccine have been administered globally to combat SARS-CoV-2 infection (1). Third and even fourth vaccine booster doses are being administered in many countries to improve immunity (39). However, many low-income nations are still waiting to offer the initial doses (1). Vaccine inequity has enabled SARS-CoV-2 to spread rapidly, increasing the incidence of sequelae, and undermining global COVID-19 recovery efforts (40). Fair allocation of vaccines is critical for effective COVID-19 control and elimination in resource-limited settings. Fortunately, more countries are taking further action. In November 2021, President Xi announced that China would provide 1.0 billion, including 600 million donated, COVID-19 vaccine doses to African countries to help reach its goal of vaccinating 60% of its population by 2022 (41). Countries will need to collaborate to create a fairer vaccination environment required to bolster worldwide immunity.

In addition, therapeutic regimens, including small-molecule inhibitors and traditional medicine, are still needed. Small-molecule inhibitors are being widely studied and play an essential function in COVID-19 treatment. Gilead's controversial drug,

Veklury[®], was conditionally approved by the Food and Drug Administration (FDA) to combat the pandemic (42, 43) and Pfizer's oral broad-spectrum candidate, Paxlovid[®], and Merck's oral prodrug, Lagevrio[®], provide new hope for a COVID-19 cure (44). Even with promising clinical results, however, widespread use of these treatments may increase the virus' resistance to inhibitors. Researchers will need to carefully design more aggressive and effective strategies to address therapeutic limitations and uncertainties. For example, multi-target drug combination therapy (PF-07321332 + Remdesivir, Linoleic acid + Remdesivir, PF-07321332 + Molnupiravir), could enhance synergistic anti-COVID-19 efficacy while also reducing drug resistance (45). Traditional medicine is another valuable tool that should be considered for COVID-19 treatment. Many studies have shown that herbal medicine offers multi-organ protection against SARS-CoV-2 (46). Ye et al. (47) illustrated that licorice-saponin A3 and glycyrrhetinic acid, triterpenoids isolated from Gan-Cao, have strong inhibitory potency against SARS-CoV-2 infection at EC_{50} values of 75 nM against the SARS-CoV-2 nsp7 protein and 3.17 μM against the Spike protein. In the COVID-19 era, small-molecule inhibitors and traditional medicine have a distinct advantage and should be shared between laboratories.

PASC rehabilitation measures, such as multi-disciplinary PASC collaboration, are also critical. A database that includes the physiology, serological, clinical imaging, and epidemiological characteristics of PASC is required to better understand the condition. In addition, fundamental science research, including an understanding of the mechanisms of viral replication, disease pathogenesis, and host immunity is required to direct the earlier evaluation and future rehabilitation of survivors. Healthcare professionals will need to recognize and document pulmonary complications to improve mental and physical health by providing timely team-based, high-quality rehabilitation nursing to survivors. In short, clinical trials of the PASC and additional anti-PASC treatment options are required to fully understand and address this medical issue.

AUTHOR CONTRIBUTIONS

ZW: conceptualization, writing—original draft, writing—review and editing, visualization, and funding acquisition. LY: conceptualization, writing—review and editing, and funding acquisition. All authors contributed to the article and approved the submitted version.

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REFERENCES

1. World Health Organization. *WHO Coronavirus (COVID-19) Dashboard.* Available online at: https://covid19.who.int/ (assessed April 28, 2022).

2. Wang Z, Yang L. In the age of omicron variant: paxlovid raises new hopes of COVID-19 recovery. *J Med Virol.* (2022) 94:1766–7. doi: 10.1002/jmv.27540

3. Sidik SM. Heart-disease risk soars after COVID—even with a mild case. *Nature.* (2022) 602:560. doi: 10.1038/d41586-022-00403-0

4. Writing Committee, Gluckman TJ, Bhave NM, Allen LA, Chung EH, Spatz ES, et al. ACC expert consensus decision pathway on cardiovascular sequelae of COVID-19 in adults: myocarditis and other myocardial involvement, post-acute sequelae of SARS-CoV-2 infection, and return to play: a report of the American college of cardiology solution set oversight committee. *J Am Coll Cardiol.* (2022) 79:1717–56. doi: 10.1016/j.jacc.2022.02.003

5. Su Y, Yuan D, Chen DG, Ng RH, Wang K, Choi J, et al. Multiple early factors anticipate post-acute COVID-19 sequelae. *Cell.* (2022) 185:881–95. doi: 10.1016/j.cell.2022.01.014

6. Cohen K, Ren S, Heath K, Dasmariñas MC, Jubilo KG, Guo Y, et al. Risk of persistent and new clinical sequelae among adults aged 65 years and older during the post-acute phase of SARS-CoV-2 infection: retrospective cohort study. *BMJ.* (2022) 376:e068414. doi: 10.1136/bmj-2021-068414

7. Buonsenso D, Di Giuda D, Sigfrid L, Pizzuto DA, Di Sante G, De Rose C, et al. Evidence of lung perfusion defects and ongoing inflammation in an adolescent with post-acute sequelae of SARS-CoV-2 infection. *Lancet Child Adolesc Health.* (2021) 5:677–80. doi: 10.1016/S2352-4642(21)00196-6

8. Lund LC, Hallas J, Nielsen H, Koch A, Mogensen SH, Brun NC, et al. Post-acute effects of SARS-CoV-2 infection in individuals not requiring hospital admission: a Danish population-based cohort study. *Lancet Infect Dis.* (2021) 21:1373–82. doi: 10.1016/S1473-3099(21)00211-5

9. Fabbri L, Moss S, Khan FA, Chi W, Xia J, Robinson K, et al. Parenchymal lung abnormalities following hospitalisation for COVID-19 and viral pneumonitis: a systematic review and meta-analysis. *Thorax.* (2022). doi: 10.1101/2021.03.15.21253593. [Epub ahead of print].

10. Long Q, Li J, Hu X, Bai Y, Zheng Y, Gao Z. Follow-ups on persistent symptoms and pulmonary function among post-acute COVID-19 patients: a systematic review and meta-analysis. *Front Med.* (2021) 8:702635. doi: 10.3389/fmed.2021.702635

11. Han Q, Zheng B, Daines L, Sheikh A. Long-term sequelae of COVID-19: a systematic review and meta-analysis of one-year follow-up studies on post-COVID symptoms. *Pathogens.* (2022) 11:269. doi: 10.3390/pathogens11020269

12. Huang L, Yao Q, Gu X, Wang Q, Ren L, Wang Y, et al. 1-year outcomes in hospital survivors with COVID-19: a longitudinal cohort study. *Lancet.* (2021) 398:747–58. doi: 10.1016/S0140-6736(21)01755-4

13. Evans RA, McAuley H, Harrison EM, Shikotra A, Singapuri A, Sereno M, et al. Physical, cognitive, and mental health impacts of COVID-19 after hospitalisation (PHOSP-COVID): a UK multicentre, prospective cohort study. *Lancet Respir Med.* (2021) 9:1275–87. doi: 10.1016/S2213-2600(21)00383-0

14. Alkodaymi MS, Omrani OA, Fawzy NA, Abou Shaar B, Almamlouk R, Riaz M, et al. Prevalence of post-acute COVID-19 syndrome symptoms at different follow-up periods: a systematic review and meta-analysis. *Clin Microbiol Infect.* (2022) 28:657–66. doi: 10.1016/j.cmi.2022.01.014

15. Al-Aly Z, Xie Y, Bowe B. High-dimensional characterization of post-acute sequelae of COVID-19. *Nature.* (2021) 594:259–64. doi: 10.1038/s41586-021-03553-9

16. Xie Y, Xu E, Bowe B, Al-Aly Z. Long-term cardiovascular outcomes of COVID-19. *Nat Med.* (2022) 28:583–90. doi: 10.1038/s41591-022-01689-3

17. Abbasi J. The COVID heart—one year after SARS-CoV-2 infection, patients have an array of increased cardiovascular risks. *JAMA.* (2022) 327:1113–4. doi: 10.1001/jama.2022.2411

18. Rizvi ZA, Dalal R, Sadhu S, Binayke A, Dandotiya J, Kumar Y, et al. Golden Syrian hamster as a model to study cardiovascular complications associated with SARS-CoV-2 infection. *eLife.* (2022) 11:e73522. doi: 10.7554/eLife.73522

19. Maio SD, Lamina C, Coassin S, Forer L, Würzner R, Schönherr S, et al. Lipoprotein (a) and SARS-CoV-2 infections: susceptibility to infections, ischemic heart disease and thromboembolic events. *J Intern Med.* (2022) 291:101–7. doi: 10.1111/joim.13338

20. Davis HE, Assaf GS, McCorkell L, Wei H, Low RJ, Re'em Y, et al. Characterizing long COVID in an international cohort: 7 months of symptoms and their impact. *eClinicalMedicine.* (2021) 38:101019. doi: 10.1016/j.eclinm.2021.101019

21. York A. SARS-CoV-2 sensory loss. *Nat Rev Microbiol.* (2022) 20:190. doi: 10.1038/s41579-022-00707-y

22. Menni C, Valdes AM, Polidori L, Antonelli M, Penamakuri S, Nogal A, et al. Symptom prevalence, duration, and risk of hospital admission in individuals infected with SARS-CoV-2 during periods of omicron and delta variant dominance: a prospective observational study from the ZOE COVID study. *Lancet.* (2022) 399:1618–24. doi: 10.1016/S0140-6736(22)00327-0

23. Zazhytska M, Kodra A, Hoagland DA, Frere J, Fullard JF, Shayya H, et al. Non-cell-autonomous disruption of nuclear architecture as a potential cause of COVID-19-induced anosmia. *Cell.* (2022) 185:1052–64. doi: 10.1016/j.cell.2022.01.024

24. Kraus A, Huertas M, Ellis L, Boudinot P, Levraud JP, Salinas I. Intranasal delivery of SARS-CoV-2 Spike protein is sufficient to cause olfactory damage, inflammation and olfactory dysfunction in zebrafish. *Brain Behav Immun.* (2022) 102:341–59. doi: 10.1016/j.bbi.2022.03.006

25. Douaud G, Lee S, Alfaro-Almagro F, Arthofer C, Wang C, McCarthy P, et al. SARS-CoV-2 is associated with changes in brain structure in UK Biobank. *Nature.* (2022) 604:697–707. doi: 10.1038/s41586-022-04569-5

26. Gollub RL. Brain changes after COVID revealed by imaging. *Nature.* (2022) 604:633–4. doi: 10.1038/d41586-022-00503-x

27. Szabo MP, Iba M, Nath A, Masliah E, Kim C. Does SARS-CoV-2 affect neurodegenerative disorders? TLR2, a potential receptor for SARS-CoV-2 in the CNS. *Exp Mol Med.* (2022) 54:447–54. doi: 10.1038/s12276-022-00755-7

28. Semerdzhiev SA, Fakhree M A, Segers-Nolten I, Blum C, Claessens MM. Interactions between SARS-CoV-2 N-protein and α-synuclein accelerate amyloid formation. *ACS Chem Neurosci.* (2022) 13:143–50. doi: 10.1021/acschemneuro.1c00666

29. Fearon C, Mikulis DJ, Lang AE. Parkinsonism as a sequela of SARS-CoV-2 infection: pure hypoxic injury or additional COVID-19-related response? *Movement Disord.* (2021) 36:1483–4. doi: 10.1002/mds.28656

30. Reveret L, Leclerc M, Emond V, Loiselle A, Bourassa P, Tremblay C, et al. Higher ACE2 expression in the brains of individuals with Alzheimer's disease. *Alzheimers Dement.* (2021) 17:e055278. doi: 10.1002/alz.055278

31. Shen WB, Logue J, Yang P, Baracco L, Elahi M, Reece EA, et al. SARS-CoV-2 invades cognitive centers of the brain and induces Alzheimer's-like neuropathology. *bioRxiv. [Preprint].* (2022). doi: 10.1101/2022.01.31.478476

32. Fernandez-de-Las-Peñas C, Navarro-Santana M, Gomez-Mayordomo V, Cuadrado, ML, García-Azorín D, et al. Headache as an acute and post-COVID-19 symptom in COVID-19 survivors: a meta-analysis of the current literature. *Eur J Neurol.* (2021) 28:3820–5. doi: 10.1111/ene.15040

33. Montefusco L, Ben Nasr M, D'Addio F, Loretelli C, Rossi A, Pastore I, et al. Acute and long-term disruption of glycometabolic control after SARS-CoV-2 infection. *Nat Metab.* (2021) 3:774–85. doi: 10.1038/s42255-021-00407-6

34. Ayoubkhani D, Khunti K, Nafilyan V, Maddox T, Humberstone B, Diamond I, et al. Post-covid syndrome in individuals admitted to hospital with covid-19: retrospective cohort study. *BMJ.* (2021) 372:n693. doi: 10.1136/bmj.n693

35. Phetsouphanh C, Darley DR, Wilson DB, Howe A, Munier C, Patel SK, et al. Immunological dysfunction persists for 8 months following initial mild-to-moderate SARS-CoV-2 infection. *Nat immunol.* (2022) 23:210–6. doi: 10.1038/s41590-021-01113-x

36. Wang Z, Yang L. Broad-spectrum prodrugs with anti-SARS-CoV-2 activities: strategies, benefits, and challenges. *J Med Virol.* (2022) 94:1373–90. doi: 10.1002/jmv.27517

37. Kozlov M. Merck's COVID pill loses its lustre: what that means for the pandemic. *Nature.* (2022). doi: 10.1038/d41586-021-03667-0. [Epub ahead of print].

38. Du Y, Chen L, Shi, Y. Safety, immunogenicity, and efficacy of COVID-19 vaccines in adolescents, children, and infants: a systematic review and meta-analysis. *Front Public Health.* (2022) 10:829176. doi: 10.3389/fpubh.2022.829176

39. Tanne JH. Covid 19: US cases rise amid omicron fears but booster shots offer protection, experts say. *BMJ.* (2021) 375:n3098. doi: 10.1136/bmj.n3098

40. Hassan F, London L, Gonsalves G. Unequal global vaccine coverage is at the heart of the current covid-19 crisis. *BMJ.* (2021) 375:n3074. doi: 10.1136/bmj.n3074

41. Xu W. *Xi: China to Provide 1b More Vaccine Doses to Africa.* Available online at: http://www.chinadaily.com.cn/a/202111/29/WS61a4c26aa310cdd39bc782ff.html

42. Schwartz IS, Heil EL, McCreary EK. Remdesivir: a pendulum in a pandemic. *BMJ.* (2020) 371:m4560. doi: 10.1136/bmj.m4560

43. Wang Z, Yang, L. GS-5734: a potentially approved drug by FDA against SARS-CoV-2. *N J Chem.* (2020) 44:12417–29. doi: 10.1039/D0NJ02656E

44. Cully M. A tale of two antiviral targets — and the COVID-19 drugs that bind them. *Nat Rev Drug Discov.* (2022) 21:3–5. doi: 10.1038/d41573-021-00202-8

45. Yang L, Wang Z. Natural products, alone or in combination with FDA-approved drugs, to treat COVID-19 and lung cancer. *Biomedicines.* (2021) 9:689. doi: 10.3390/biomedicines9060689

46. Wang Z, Yang L. Chinese herbal medicine: fighting SARS-CoV-2 infection on all fronts. *J Ethnopharmacol.* (2021) 270:113869. doi: 10.1016/j.jep.2021.113869

47. Yi Y, Li J, Lai X, Zhang M, Kuang Y, Bao YO, et al. Natural triterpenoids from licorice potently inhibit SARS-CoV-2 infection. *J Adv Res.* (2022) 36:201–10. doi: 10.1016/j.jare.2021.11.012

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Check for updates

Impact of the Pandemic on Selected Aspects of Health-Promoting Attitudes in 2020–2021: A Cross-Sectional Study

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Introduction: In the face of the COVID-19 pandemic, people began to change both their health-promoting and anti-health behaviors.

Aim of the Paper: To assess the impact of the pandemic on selected health-promoting attitudes.

Methods: The cross-sectional study was conducted from March 2020 to September 2021. We have used the author's survey questionnaire and the standardized Wellness Behaviors Inventory (WBI). The questionnaires were given to respondents in paper versions to fill it.

Results: The study group included 600 urban residents aged 32–73. Based on the opinions of the respondents, during the pandemic, the following activities increased the most: hand washing (93.3%), eating sweets and snacks (80%), and surfing the Internet (60%). An increase in drug/legal use was reported by 13.3%, with no indication of a decrease or no change in consumption of the above. The overall WBI index for all subjects before the pandemic was 81.3 ± 20.2 points, and the increase significantly ($p < 0.001$) during the pandemic was 87.7 ± 16.7 points. In addition, an increase in preferred eating habits was found (from 19.5 ± 6.4 to 21.1 ± 6.9 points; $p < 0.001$), preferred prophylactic behaviors (from 21.1 ± 6.0 to 22.7 ± 5.2 points; $p < 0.001$) and level of presented health practices during the pandemic (from 20.3 ± 5.1 to 24.7 ± 2.7 points; $p < 0.001$), and a decrease significantly ($p < 0.001$) in the degree of positive mental attitude (from 20.3 ± 5.4 points to 19.3 ± 4.9 points).

Conclusions: Respondents generally rated their own and their family's health as worse during the pandemic period, and this trend continued when broken down by gender, cohabitant, place of residence, and education. According to the largest group of respondents, the frequency of handwashing, eating sweets and snacks, surfing the Internet, and using drugs/legal highs increased the most during the pandemic. The

overall WBI index for all respondents before and during the pandemic was slightly higher during the pandemic period. Monitoring health behavior during a pandemic is essential for prevention and health care institutions. Further studies are needed to assess the long-term impact of the pandemic on pro-and anti-health behavior of people.

INTRODUCTION

The concepts of health and disease, which are closely intertwined, have been of interest to humans since the beginning of our civilization, and their definition has been evolving over the centuries. In 1948, the World Health Organization (WHO), adopted a definition that stated that health is "a state of complete physical, mental and social wellbeing and not merely the absence of disease or infirmity[1]". This definition has been subjected to various modifications over the years, which broadened the scope of health and emphasized the role of its determinants, which led to an interdisciplinary perception of health and the involvement of humanists in cooperation with the medical community (1). The concept of health can also be determined in disciplinary (various approaches of different scientific disciplines to health issues), historical (concerning the development of sciences), and cultural terms (criteria of health, disease, and prevention, as well as the values given to human health in different cultures) (2). The development of medicine, a biomedical approach to health and disease, was formed, which defines health as a physiological and biological state of the body that ensures its proper functioning as a biological whole (2). Health can also be conceptualized as the body's state of equilibrium (homeostasis), in which it functions at an optimal level, and disease occurs when this equilibrium is disturbed, usually under the influence of a disease factor (3). The concept of health can also be considered in three dimensions: the ability to perform the activities of daily living, mental wellbeing, and adherence to health-promoting behaviors (4). Talcott Parsons (5), the creator of the sociological and functionalist concept of health, defines health to be "the state of optimum capacity of an individual for the effective performance of the roles and tasks for which he has been socialized" and disease is a state in which an individual cannot fulfill his/her social roles. Another concept of understanding health is holism, which is a view that denotes holistically explaining various phenomena, including all spheres of human life (biological, mental, social, spiritual) and focusing not only on the biological sphere of man but also on the psychological, social and cultural contexts, which determine health and disease to a greater or lesser extent (6).

The literature (7–9) distinguishes four dimensions of health: biological, psychological, social, and spiritual, and two perspectives of it: objective (medical, psychological) and subjective (from the patient's point of view), the variability of health is emphasized (human life is a process of continuous efforts and changes), the positive understanding of health is stressed (as a potential/resource), the concept of health is identified with the concepts of happiness, wellbeing and quality of life (a sense of happiness is a symptom of health, and health is an essential condition of happiness), and the principle 'your health in your hands' is promoted, whereby everyone is held accountable for their health.

Any behavior that affects a person's health status, either positively or negatively, is considered to be a health-related behavior. Daily habits involving diet, exercise, safety practices, and substance use are not only related to the prevention of disease but also affect the management of chronic illness and degree of disability (10). Common health-related behaviors include diet, exercise, smoking, alcohol use, safety practices, and participation in health screening examinations such as testing for cholesterol levels, and breast and prostate cancer (11).

Regular physical activity is associated with lower death rates for adults and decreases the risk of death from heart disease, lowers the risk of developing diabetes, and helps reduce blood pressure.

The study aimed to assess the impact of the pandemic on selected health-promoting attitudes. We established two research hypotheses. The first one was that the threat related to the risk of Infection with an unknown and dangerous pathogen and a complete change in everyday functioning contributed to positive health-promoting behaviors. The second one was that the pandemic influenced the feeling of deterioration in health.

MATERIALS AND METHODS

The permission of the Bioethics Committee APK.002.184.2021 was obtained for conducting the research. The cross-sectional study was conducted from March 2020 to September 2021. A total of 730 questionnaires in a paper version were distributed. In return, we received 600 fully completed questionnaires and qualified for the study. The conditions for entering the study included residence in the city and completion of an anonymous survey.

The study was conducted using the author's survey questionnaire and the standardized Wellness Behaviors Inventory (WBI). The author's survey was initially conducted on a group of 100 people to check the clarity/intelligibility of the questions. The respondents' comments were introduced into the final version of the survey.The WBI questionnaire contained 24 statements describing various health-related behaviors (eating habits, prophylactic behaviors, positive mental attitudes, health practices). The respondent indicated how often they performed a given health-related activity by rating each of the listed behaviors on a five-point scale: (1) hardly ever, (2) rarely, (3) occasionally,

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[1]https://www.who.int/governance/eb/who_constitution_en.pdf (accessed April 4, 2022).

(4) often, (5) almost always. Because of the possibility of periodic preference for certain types of health behaviors, it was assumed that the recent year should only be considered in the evaluation. The numerical values marked by the respondent were counted to obtain a range of 24–120 points. The higher the score obtained by the respondent, the higher the intensity of health behaviors he or she declared. When converted to standardized units based on the table below, the overall index was subject to interpretation according to the properties that characterize the sten score. Results within: 1–4 sten were treated as low scores; 7–10 sten—as high; 5 and 6 sten—as average (12).

The internal concordance of the WBI, as determined by Cronbach's *alpha*, is 0.85 for the entire Inventory and ranges from 0.60 to 0.65 for its four subscales. Chi^2-test with Yate's correction was conducted.

RESULTS

The cross-sectional study was conducted on the group of 600 urban residents (73.3% residents of cities with a population of 200,000–500,000; 13.3% with a population of 50,000–100,000; and 6.7% with a population of up to 50,000 or more than 500,000). There were 69.2% females in the study group, with a mean age of 58.9 ± 11.9, and 30.8% males aged 57.6 ± 12.1. In general, the age of the respondents ranged from 32 to 73. The largest number of people lived with their spouse, 53.3%. Twenty-eight percent of the respondents lived with a spouse and children, 12% were single, and 6.7% lived with children only. 66.7% of the respondents had higher education, and 33.3% – had secondary education.

In the first part of the survey, respondents were asked to rate their health before and during the pandemic. In general, respondents rated them as worse during the pandemic period. This trend continued when broken down by gender, co-residence, place of residence, and education. The results are illustrated in **Table 1**.

The respondents were then asked to rate their family's health status before and during the pandemic. In general, the respondents rated their family's health, as in the case of their own health, to be worse during the pandemic. This trend continued, as it did in the case of their own health, when broken down by gender, co-residence, place of residence, and education. The results are illustrated by **Table 2**.

According to the opinions of the majority of respondents, the following activities increased the most: hand washing (93.3%), eating sweets and snacks (80%), and surfing the Internet (60%). However, the consumption of sweetened soft drinks (73.3%), consumption of cereal products (66.7%), consumption of fish, dairy products, and eggs, unsweetened beverages, and drinking coffee (60% each) did not change according to the respondents. The remaining indications are presented in **Table 3**.

The overall WBI index for all subjects before the pandemic was 87.3 ± 20.2 points. (Min.−26 points and Max−105 points) and 5.7 ± 2.1 sten (Min.−1; Max.−9), and during the pandemic, 87.7 ± 16.7 points (Min.−46; Max.−114) and 6.2 ± 2.4 sten (Min.−1; Max.−10), – which indicates an average level of health behaviors, slightly higher during the pandemic. In general, low levels of health behavior were presented by 20% of the respondents before the pandemic and by 13.3% during the pandemic. The average level of health behavior was presented by 40% of the respondents before the pandemic and 26.7% during the pandemic, whereas high level of health behavior was presented by 40% of the respondents before the pandemic and 60% during the pandemic period. Detailed data are provided in **Table 4**.

Before, as well as during the pandemic, higher rates of health-related behaviors were characterized by males, people with secondary education, people living with children, and residents of cities with populations over 500,000. Detailed results are shown in **Table 5**.

There was a general increase in preferred eating habits in the study group during the pandemic (from 19.5 ± 6.4 points to 21.1 ± 6.9 points). The upward trend continued regardless of gender or co-residence. There was also an increase among people with higher education and residents of cities with up to 50,000 and cities with a population of 200,000 to 500,000. The habits did not change in the group with secondary education and in the groups of inhabitants of cities with 50,000 to 100,000 and over 500,000 residents. The results are illustrated in **Table 6**.

A general increase in the preferred prophylactic behaviors in the study group during the pandemic was observed (from 21.1 ± 6.0 points to 22.7 ± 5.2 points). The upward trend continued regardless of gender, co-residents, education, and place of residence, except for the residents of cities with a population of up to 50,000 inhabitants and over 500,000 inhabitants - where it did not change, and the group of city residents with the population between 50,000 and 100,000, where it decreased. The results are illustrated in **Table 7**.

In general, the degree of positive mental attitude was found to decrease significantly ($p < 0.001$) in the study group during the pandemic (from 20.3 ± 5.4 points to 19.3 ± 4.9 points). A similar trend was observed in females and males; in the case of single persons and those living with a spouse, with no changes in the case of persons living with children or with a spouse and children; in the case of persons with secondary education, with practically no differences in the case of persons with higher education and the case of inhabitants of cities with the population of 50,000–100,000 and over 500,000, with practically no changes in the case of inhabitants of cities with the population of 200,000–500,000 and with the degree of positive mental attitude increasing from 18.0 ± 2.6 points to 20.2 ± 0.3 points in residents of cities up to 50,000 inhabitants. Detailed results are shown in **Table 8**.

Health practices in the WBI questionnaire include daily sleep and recreation habits or physical activity. Overall, an increase in the level of health practices presented during the pandemic was shown (from 20.3 ± 5.1 points to 24.7 ± 2.7 points). This trend continued irrespective of gender, education, place of residence, and co-residents, except for the group of people living with children, where no differences in this respect were observed. Detailed data are provided in **Table 9**.

TABLE 1 | Respondents' assessment of their health status – before and during the pandemic.

	Before the pandemic			During the pandemic		
Opinion	Total N = 600	Female N = 415	Male N = 185	Total N = 600	Female N = 415	Male N = 185
Gender						
Better	482	330	152	0	0***	0***
No changes	117	84	33	95	63	32
Worse	1	1	185	416	263***	153

Opinion	Total N = 600	Single N = 72	With children N = 40	With spouse N = 320	With spouse and children N = 168	Total N = 600	Single N = 72	With children N = 40	With spouse N = 320	With spouse and children N = 168
Co-residents										
Better	482	68	28	262	124	1	0***	0	1*	0***
No changes	117	4	12	57	44	118	2	12	60	44
Worse	1	0	0	1	0	481	70***	28***	259***	124***

Opinion	Total N = 600	Up to 50,000 N = 40	50,000 - 100,000 N = 80	200,000 - 500,000 N = 440	>500,000 N = 40	Total N = 600	Up to 50,000 N = 40	50,000 - 100,000 N = 80	200,000 - 500,000 N = 440	>500,000 N = 40
City of residence										
Better	482	36	52	358	36	1	0***	0***	1***	0
No changes	117	4	28	81	4	118	4	28	82	4
Worse	1	0	0	1	0	481	36***	52***	357***	36***

Opinion	Total N = 600	Secondary N = 200	Higher N = 400	Total N = 600	Secondary N = 200	Higher N = 400
Education						
Better	482	174	308	1	0***	1***
No Changes	117	19	98	118	19	99
Worse	1	0	1	481	174***	307***

*p < 0.05.
***p < 0.001 before vs. during the COVID-19 pandemic Chi^2-test with Yate's correction.

DISCUSSION

The current study aimed to assess the impact of the COVD-19 pandemics on selected health-promoting behaviors among adult city residents. The respondents generally rated their own and their family's health as worse during the pandemic. There was also an increase in preferred eating habits, preferred prophylactic behaviors, presented health practices, and a decrease in the degree of positive mental attitude.

The changes that occurred due to the pandemic were multifaceted, as they affected not only the society as a whole but above all, every individual. The sheer risk associated with the danger of Infection with an unknown and dangerous pathogen and a complete change in the scope of everyday functioning could undoubtedly become a reason for changes in health-promoting behavior. They are shaped by many factors, such as conscious choices and lifestyles, and health habits formed during socialization and modified and reinforced in adulthood (13).

The pandemic has impacted Poles started approaching their health. It has been shown that more than half of the respondents admitted that they care about their health more than in the corresponding period of the previous year (including 25% of Poles who "care much more about their health")[2]. In the present study, the respondents rated their health status, as well as the health of their families, as worse during the pandemic compared to the period before it. This trend continued regardless of gender, co-residents, place of residence, or education.

The respondents took the most often to take care of their health (physical and mental) included getting enough sleep, enough rest, and eating healthy foods (14, 15). The study 'Hygiene habits of Poles during the coronavirus pandemic' commissioned by NAOS in May 2021 on a representative group of Poles (1,025) aged 18–65, who completed an online survey, showed that in the first months of the pandemic, the percentage of persons who washed hands increased to 65% (14).

One aspect of health-promoting behavior includes proper eating habits – primarily the type of consumed food. According to the study by Sidor and Roman (16), 45.3% of

[2]https://www.rynekzdrowia.pl/Uslugi-medyczne/Badanie-IBRiS-ponadpolowa-Polakow-dba-o-swoje-zdrowie-bardziej-niz-przed-rokiem,206687,8.html (accessed April 4, 2022).

TABLE 2 | Respondents' assessment of the health status of their families – before and during the pandemic.

	Before the pandemic N = 600			**During the pandemic N = 600**		
Opinion	**Total** N = 600	**Female** N = 415	**Male** N = 185	**Total** N = 600	**Female** N = 415	**Male** N = 185
Gender						
Better	387	255	132	0	0***	0***
No changes	209	156	56	144	104***	40
Worse	4	4	0	456	311***	145***

Opinion	**Total N = 600**	**Single** N = 72	**With children** N = 40	**With spouse** N = 320	**With spouse and children** N = 168	**Total** N = 600	**Single** N = 72	**With children** N = 40	**With spouse** N = 320	**With spouse and children** N = 168
Whom the respondents live with										
Better	387	61	22	205	99	0	0***	0***	0***	0***
No changes	209	10	18	113	68	144	5	14	76*	49
Worse	4	1	0	2	1	456	67***	26*	244***	119***

Opinion	**Total N = 600**	**Up to 50,000** N = 40	**50,000–100,000 N = 80**	**200,000–500,000** N = 440	**>500,000 N = 40**	**Total** N = 600	**Up to 50,000** N = 40	**50,000–100,000** N = 80	**200,000–500,000 N = 440**	**>500,000** N = 40
City of residence										
Better	387	29	43	286	29	0	0***	0***	0***	0***
No changes	209	11	36	151	11	144	5	31	104**	4
Worse	4	0	1	3	0	456	35***	49***	336***	36***

Opinion	**Total** N = 600	**Secondary** N = 200	**Higher** N = 400	**Total** N = 600	**Secondary** N = 200	**Higher** N = 400
Education						
Better	387	174	308	0	0***	1***
No changes	209	19	98	144	19	99
Worse	4	0	1	456	174***	307***

*p < 0.05.
***p < 0.001 before vs. during the COVID−19 pandemic Chi^2-test with Yate's correction.

subjects consumed more food during the lockdown than the period before the pandemic. Also, the results from the international ECLB-COVID-19 study, conducted *via* an online survey among Asian, European, and African subjects, indicated an increase in consumption of unhealthy snacks, uncontrolled eating, eating between meals, an increased number of consumed meals (14). However, in the present study, the pandemic was conducive to increasing good eating habits.

An essential aspect of health-promoting activities is prophylactic behavior. Wypych-Slusarska et al. (16), in a group of 245 Polish adults, assessed the frequency of consuming selected products and the use of supplementation and prophylactic behaviors related to COVID-19 pandemic. The measures taken by the study participants to boost immunity included vaccinations and vitamin D and C supplementation. In the present study, it was generally found that the number of preferred prophylactic behaviors increased during the pandemic, regardless of gender, co-residents, education, and residence in cities of 200,000–500,000 residents.

Physical activity is another important aspect of health-promoting behavior. In a systematic review related to physical activity during the COVID-19 pandemic (16), Caputo and Reichert (17) found that social isolation affected the decrease in physical activity. The results of Lesser and Nienhuis' study also indicated that physical activity reduced anxiety. Confirmation of the above was also found in the present study. In contrast, in the study by Wypych-Slusarska et al. nearly half of the respondents reported that their level of physical activity did not change during the pandemic. However, when they reopened in the summer of 2020, activity increased by 2 to 62% at that time (18). In a survey conducted in Poland on a representative sample of 1,000 Poles over the age of 18, from 23 to April 30 2020, before the pandemic 65% undertook physical activity at least once a month. During the pandemic, 43% were physically active (19). In the present study, a general increase in the health practices presented during the pandemic. During the pandemic, respondents rested more, avoided overwork, spent more time sleeping, and avoided excessive exercise. This trend continued irrespective of gender, education, place of

TABLE 3 | Respondents' views on changes in health-promoting and anti-health behavior during the pandemic.

Type of health-promoting/anti-health behavior	Opinion (number of people)			
	Does not concern me	Decrease	No changed	Increased
Smoking	476	72	40	12
Drinking alcohol	400	40	40	120
Use of drugs/legal highs	520	0	0	80
Regular physical exercise	40	392	40	128
Walking	0	312	200	88
Cycling	280	152	120	48
Eating regularly	0	152	280	168
Consumption of sweets and snacks (e.g. sugar, honey, chocolates, cookies etc.)	0	80	40	480
Consumption of fat (oil, butter, margarine, cream, sour cream, mayonnaise, etc.)	0	160	200	240
Eating fruit (fruit, kiwi, citrus fruit, berries, dried fruit, etc.)	0	112	200	288
Eating vegetables and grains (vegetables, leafy green vegetables, seeds, nuts etc.)	0	112	280	208
Fish consumption	0	192	360	48
Consumption of meat products (sausages, cold cuts, red meat, poultry, etc.)	0	160	320	120
Consumption of dairy products and eggs (milk, yogurt, cocoa, cheese, scrambled eggs, etc.)	0	0	360	240
Eating cereal products (wholemeal bread, refined breads, groats, etc.)	0	152	400	48
Eating fast food (e.g., KFC, McDonald's, etc.)	360	80	80	80
Consumption of sweetened soft drinks (fruit nectars, sweetened soft drinks)	0	80	440	80
Consumption of unsweetened soft drinks (100% vegetable juices, vegetable-fruit juices, fruit juices)	0	120	360	120
Drinking coffee	80	40	360	120
Sleeping at least 7–9 h	0	320	160	120
Hand washing	0	40	0	560
Surfing the Internet	0	40	200	360

residence, and co-residents, except for the group of people living with children, where no differences in this respect were observed.

Adopting a positive mindset is conducive to better health and maintaining mental resilience. The Dialogue Therapy Center asked a representative sample of 350 psychiatrists from across the country how they assess the current mental state of Poles. It turned out that 74.3% of the respondents felt it was worse than two years ago, i.e., before the COVID-19 outbreak (20). According to a survey conducted by UCE RESEARCH and SYNO Poland, among 1,040 Poles aged 18–80, 38.5% of respondents believed their mental health deteriorated during the pandemic[3]. The study found that 68% of the respondents who identified mental health deterioration syndromes had not noticed them before the pandemic. The most commonly reported symptoms of impaired mental health were lowered mood, sleep disturbances, impaired concentration and attention, a pessimistic view of the future, and low self-esteem and self-confidence. In the present study, the positive mental attitudes of the respondents were assessed using the WBI questionnaire. The study group showed a decrease in positive mental attitude during the pandemic. A similar trend was observed in females and males, and single persons. Also, education had no impact in positive mental attitude during the pandemic. The number of reposndents who declared 'almost always' when taking tips from people who expressed concern about their health decreased (from 20% pre-pandemic to 13.3% during the pandemic).

In contrast, there was an increase in 'almost always' statements regarding avoiding situations that make the respondents feel depressed (from 13.3% pre-pandemic to 20% during the pandemic). This issue of avoiding overly strong emotions, stress, and tension, and feelings such as anger, anxiety, and depression remained at a similar level (13.3% before and during the pandemic). Interestingly, 33.3% of the respondents declared before the pandemic that they "almost always" had friends and settled family life, while no one thought so during the pandemic. The number of those

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[3]https://pulsmedycyny.pl/psychiatrzy-coraz-wiecej-polakow-w-gabinetachrosnie-liczba-interwencji-kryzysowych-sondaz-1129775 (accessed April 04, 2022).

TABLE 4 | The type of health-related behaviors before and during the pandemic presented by all respondents.

WBI	Before the pandemic $N = 600$					During the pandemic $N = 600$				
	Hardly ever	rarely	Occasionally	often	Almost always	Hardly ever	rarely	Occasionally	often	Almost always
I eat a lot of vegetables and fruits	40	80	200	200	80	40	40***	160	240	120*
I avoid catching colds	80	40	120	200	160	80	0***	40***	280**	200
I take the advice of persons who express concern about my health seriously	120	40	80	240	120	120	160***	120*	120***	80*
I rest enough	80	120	120	120	160	0***	40***	160*	160*	240*
I limit the consumption of such products as animal fats and sugar	80	160	200	80	80	80	80***	200	80	160***
I have the phone numbers of emergency services noted down	160	0	80	80	280	120*	0	120*	40***	320
I avoid situations that have a depressing effect on me	40	80	120	280	80	40	0***	160*	280	120*
I avoid overworking	80	200	80	120	120	0***	40***	80	200***	280***
I take care of proper nutrition	40	120	120	200	120	40	80*	120	160	200***
I follow my doctor's instructions based on my health status	40	80	40	280	160	80***	0***	40	200**	280
I try to avoid overly strong emotions, stress and tension	40	40	160	280	80	40	40	160	280	80
I control my weight	80	160	80	40	240	0***	80***	80	80***	360***
I avoid eating food with preservatives	0	120	160	160	160	0	120	200	40***	240***
I report regularly for medical check-ups	40	80	120	160	200	80***	80	120	80***	200
I have friends and a settled family life	80	80	160	80	200	160***	160***	120	160***	0***
I sleep enough	80	80	120	120	200	40***	40***	120	120	280*
I avoid salt and highly salted foods	120	80	160	80	160	120	40***	160	80	200
I'm trying to figure out how others avoid diseases	120	40	240	80	120	80*	0***	200	120*	200***
I avoid such feelings as anger, fear and depression	40	160	120	200	80	40	120	120	240	80
I cut down on smoking tobacco	80	0	0	120	400	0***	0	0	120	480*
I eat wholemeal bread	40	120	240	80	120	40	80*	200	80	200***
I seek to obtain medical information and understand the causes of health and illness	40	80	120	200	160	40	0***	0***	0***	560***
I have a positive thinking	80	80	120	200	320	80	80	120	160	160***
I avoid excessive physical exertion	40	120	240	200	0	80***	40***	120***	160	200***
All respondents	81.3 ± 20.2 points (26–105)					87.7 ± 16.7 points (46–114)###				
$N = 600$	5.7 ± 2.1 sten (1–9)					6.2 ± 2.4 sten (1–10)###				
	Low		120			Low		80*		
	Average		240			Average		160***		
	High		240			High		360***		

*p < 0.05.

**p < 0.01.

***p < 0.001 before vs. during the COVID-19 pandemic Chi²-test with Yate's correction.

###p < 0.001 before vs. during the COVID-19 pandemic Wilcoxon's rank test.

declaring "almost always" with regard to positive thinking also decreased (from 53.3% before the pandemic to 26.7% during the pandemic).

The Global Drug Survey report, which is based on data collected in May and June 2020 from 58,811 people in Germany, France, the United Kingdom, Ireland, Austria, the Netherlands, Switzerland, Australia, New Zealand, Brazil and the United States, showed that 43% of respondents were more likely to use alcohol during the pandemic, 39% consumed more alcohol, 29% drank less alcohol and 24% reported no change. They cited "more time to drink" as the most common reason for changing their drinking

TABLE 5 | Rates of health-related behaviors before and during the pandemic by gender, education, co-residents, and place of residence.

WBI	Before the pandemic N = 600					During the pandemic N = 600					p-value*
	Hardly ever	rarely	Occasionally	often	Almost always	Hardly ever	rarely	Occasionally	often	Almost always	
GENDER											
Females			81 ± 29.9 points					86.3 ± 16.3 points			<0.01
N = 415			5.2 ± 2.2 sten					5.8 ± 2.3 sten			<0.001
Males			81.9 ± 21 points					91 ± 17.3 points			<0.001
N = 185			6.1 ± 2.7 sten					7.2 ± 2.3 sten			<0.001
EDUCATION											
Secondary			90.6 ± 10.4 points					93.2 ± 9.2 points			<0.01
N = 200			7.2 ± 1.5 sten					7.4 ± 1.4 sten			NS
Higher			76.6 ± 22.2 points					85 ± 18.9 points			<0.001
N = 400			5.5 ± 2.6 sten					6.7 ± 2.5 sten			<0.001
CO-RESIDENTS											
Singles			81.3 ± 7.9 points					83.6 ± 4.1 points out of 120			<0.05
N = 72			5.8 ± 1.4 sten					6.3 ± 0.5 sten out of 10			<0.01
With spouse and children			82.9 ± 16.3 points					95.3 ± 14.6 points			<0.001
N = 168			6 ± 2.5 sten					7.7 ± 1.9 sten			<0.001
With spouse			78.7 ± 24.1 points					83.8 ± 18.8 points			<0.01
N = 320			5.9 ± 2.6 sten					6.2 ± 2.6 sten			NS
With children			95.4 ± 0.6 points					95.4 ± 0.6 points			NS
N = 40			8 ± 0 sten					8 ± 0 sten			NS
PLACE OF RESIDENCE											
City up to 50,000 residents N = 40			76.4 ± 0.6 points					82.2 ± 0.5 points			<0.001
			5 ± 0 sten					6.0 ± 0 sten			<0.001
City from 50,000 to 100,000 residents N = 80			74.5 ± 7.5 points					72.5 ± 3.5 points			<0.05
			5.0 ± 1.0 sten					4.5 ± 0.5 sten			<0.001
City from 200,000 to 500,000 residents N = 440			81.1 ± 22.3 points					89.5 ± 17.5 points			<0.001
			6.1 ± 2.6 sten					7.0 ± 2.3 sten			<0.001
City above 500,000 residents N = 400			102.1 ± 0.3 points					105.2 ± 0.4 points			<0.001
			9.0 ± 0 sten					9.0 ± 0 sten			NS

*Wilcoxon rank test.

style (42%) and "boredom" (41%). In contrast, the others indicated compensation for anxiety and worries caused by the pandemic (see text footnote 3). In the present survey, an increase in alcohol consumption was declared by 20% of the respondents, compared to 6.7% who said nothing had changed in this area and 6.7% who reported a decrease in alcohol use.

The report lists the top 10 most commonly identified stimulants used by respondents in 2020. Alcohol came in first (94%), followed by cannabis containing THC (64.5%), and tobacco (60.8%). In addition to alcohol and tobacco products, the list contains the following: MDMA, CBD-only (non-psychoactive) cannabis, cocaine, amphetamine, LSD, benzodiazepines, hallucinogenic mushrooms, ketamine, and prescription opioids (see text footnote 3). Lockdown was also found to increase the use of cannabis containing the psychoactive THC. Thirty-nine percent said they smoked more, but another

39% claimed they smoked the same amount, and only 21% said their marijuana use had decreased. However, the above may be related to problems of accessibility to such stimulants during the closure of borders and public places (see text footnote 3).

What may be a cause for concern in our study is that respondents reported an increase in drug/legal highs consumption.

In other studies conducted in different countries during the pandemic of COVId-19, the pandemic had a significant impact on the change of habits and psychological wellbeing of populations in different manners (e.g., smoking, physical activity, eating habits)[4] (21–28).

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[4]https://www.globaldrugsurvey.com/gds-covid-19-special-edition-key-findings-report/ (accessed April 04, 2022).

TABLE 6 | Assessment of good eating habits among the respondents before and during the pandemic by gender, education, co-residents, and place of residence.

	WBI result good eating habits		p-value*
	Before the pandemic	During the pandemic	
Total N = 600	19.5 ± 6.4 points	21.1 ± 6.9 points	<0.001
Gender			
Females N = 415	19.2 ± 6.2 points	20.4 ± 6.8 points	<0.01
Males N = 185	20.2 ± 6.7 points	22.5 ± 7.0 points	<0.01
Co-residents			
Singles N = 72	20.4 ± 3.2 points	22.1 ± 4.4 points	<0.01
With spouse and children N = 168	16.9 ± 8.2 points	20.8 ± 9.6 points	<0.001
With spouse N = 320	20.3 ± 5.7 points	20.6 ± 6.0 points	NS
With children (N = 40)	23.1 ± 0.2 points	24.6 ± 0.3 points	<0.001
Education			
Secondary N = 200	21.0 ± 3.9 points	21.0 ± 3.9 points	NS
Higher N = 400	18.8 ± 7.2 points	20.8 ± 8.0 points	<0.001
Place of residence			
City up to 50,000 residents N = 40	23.6 ± 0.2 points	26.4 ± 0.2 points	<0.001
City from 50,000 to 100,000 residents N = 80	14.4 ± 2.2 points	14.4 ± 2.2 points	NS
City from 200,000 to 500,000 residents N = 440	19.3 ± 6.2 points	21.1 ± 6.8 points	<0.001
City above 500,000 residents N = 40	30.6 ± 0.1 points	30.6 ± 0.1 points	NS

*Test-t.

TABLE 7 | Assessment of prophylactic behaviors among the respondents before and during the pandemic by gender, education, co-residents, and place of residence.

	WBI result prophylactic behaviors		p-value*
	Before the pandemic	During the pandemic	
Total N = 600	21.1 ± 6.0 points	22.7 ± 5.2 points	<0.001
Gender			
Females N = 415	21.0 ± 5.9 points	22.2 ± 5.2 points	<0.01
Males N = 185	21.4 ± 6.2 points	23.7 ± 5.2 points	<0.001
Co-residents			
Singles N = 72	22.9 ± 2.9 points	23.6 ± 2.0 points	<0.01
With spouse and children N = 168	23.8 ± 6.1 points	26.2 ± 3.7 points	<0.001
With spouse N = 320	19.1 ± 6.2 points	20.6 ± 5.7 points	<0.01
With children N = 40	23.4 ± 0.2 points	23.8 ± 0.3 points	NS
Education			
Secondary N = 200	22.6 ± 2.6 points	23.4 ± 2.3 points	<0.01
Higher N = 400	20.4 ± 7 points	22.3 ± 6.2 points	<0.001
Place of residence			
City up to 50,000 residents N = 40	24.2 ± 0.3 points	24.2 ± 0.3 points	NS
City from 50,000 to 100,000 residents N = 80	19.0 ± 4.0 points	17.0 ± 3.0 points	<0.001
City from 200,000 to 500,000 residents N = 440	20.6 ± 6.4 points	23.1 ± 5.2 points	<0.001
City above 500,000 residents N = 40	28.6 ± 0.2 points	28.6 ± 0.2 points	NS

*Test-t.

This may indicate that the pandemic has had a global impact on health behaviors.

Limitations of the Study

The study group included a population of only 600 residents, so it cannot be generalized to the entire population of Poland. The study was limited by the lack of inclusion of a rural population group. The study group should be larger and expanded to include such individuals in future studies.

CONCLUSIONS

The respondents rated their own and their families' health as worse during the pandemic. During the pandemic period,

TABLE 8 | Assessment of positive mental attitudes before and during the pandemic by gender, education, co-residents and place of residence.

	WBI result positive mental attitude		p-value*
	Before the pandemic	During the pandemic	
Total N = 600	20.3 ± 5.4 points	19.3 ± 4.9 points	<0.001
Gender			
Females N = 415	20.1 ± 5.3 points	18.9 ± 5.0 points	<0.001
Males N = 185	20.6 ± 5.5 points	20.0 ± 4.8 points	<0.05
Co-residents			
Singles N = 72	21.3 ± 2.9 points	20.3 ± 0.5 points	<0.01
With spouse and children N = 168	20.8 ± 4.4 points	20.7 ± 3.3 points	NS
With spouse N = 320	19.0 ± 6.0 points	17.4 ± 5.4 points	<0.001
With children (N = 40)	26.2 ± 0.3 points	26.2 ± 0.3 points	NS
Education			
Secondary N = 200	23.0 ± 2.3 points	21 ± 3.6 points	<0.001
Higher N = 400	18.9 ± 5.9 points	18.4 ± 5.3 points	NS
Place of residence			
City up to 50,000 residents N = 40	18.0 ± 2.6 points	20.2 ± 0.3 points	<0.01
City from 50,000 to 100,000 residents N = 80	17.0 ± 3.0 points	13.5 ± 1.5 points	<0.001
City from 200,000 to 500,000 residents N = 440	20.5 ± 5.7 points	20.0 ± 5.1 points	NS
City above 500,000 residents N = 40	26.2 ± 0.2 points	22.3 ± 0.5 points	<0.001

*Test – t.

TABLE 9 | Assessment of health practices among the respondents before and during the pandemic by gender, education, co-residents, and place of residence.

	WBI result health practices		p-value*
	Before the pandemic	During the pandemic	
Total N = 600	20.3 ± 5.1 points	24.7 ± 2.7 points	
Gender			
Females N = 415	20.5 ± 5.1 points	24.6 ± 2.7 points	
Males N = 185	20.0 ± 5.2 points	25.1 ± 2.8 points	
Co-residents			
Singles N = 72	18.7 ± 2.2 points	20.9 ± 0.9 points	
With spouse and children N = 168	20.0 ± 3.6 points	26.5 ± 2.3 points	
With spouse N = 320	20.3 ± 6.1 points	24.6 ± 2.5 points	
With children N = 40	25.3 ± 0.2 points	25.3 ± 0.2 points	
Education			
Secondary N = 200	23.6 ± 2.7 points	25.8 ± 0.8 points	
Higher N = 400	18.7 ± 5.2 points	24.2 ± 3.2 points	<0.001
Place of residence			
City up to 50,000 residents N = 40	16.0 ± 0 points	20.0 ± 0 points	
City from 50,000 to 100,000 residents N = 80	22.0 ± 2.01 points	26.0 ± 0 points	
City from 200,000 to 500,000 residents N = 440	20.6 ± 5.6 points	24.9 ± 2.8 points	
City above 500,000 residents N = 40	18.3 ± 0.2 points	25.8 ± 0.4 points	

*Test – t.

handwashing, consumption of sweets and snacks, Internet surfing, and drug/legal high use increased the most. The overall index of WBI for all subjects was slightly higher during the pandemic. An increase in preferred dietary habits, preferred prophylactic behaviors, and presented health practices was noted, whereas the degree of positive mental attitude decreased. Rates of health-related behaviors depended on gender, education, place of residence, and co-residents.

DATA AVAILABILITY STATEMENT

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

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Bioethics Committee of the Medical University of Bialystok APK.002.33.2021. Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

AUTHOR CONTRIBUTIONS

AK-B, EK-K, and GB: designed the study and wrote the protocol. AK-B, GB, WK, AG, JF, CŁ, MC, NW, and EK-K: data collection. WK: undertook the statistical analysis. AK-B and GB: wrote the first draft of the manuscript. All authors contributed to and have approved the final manuscript.

REFERENCES

1. Kostrzanowska Z. Uwarunkowania zachowań zdrowotnych oraz reakcja na chorobe. In: Krajewska-Kułak E, Wrońska I, Kedziora-Kornatowskiej K, editors. *Problemy Wielokulturowości w Medycynie*. Warszawa: PZWL (2010), p. 123–36.
2. Kowalski M. *Teoretyczne refleksji o zdrowiu*. In: Kowalski M, Gaweł A, editors. *Zdrowie -Wartość –Edukacja*, 2nd ed. Kraków: Oficyna Wydawnicza Impuls (2007).
3. Ziarko M. *Zachowania Zdrowotne Młodych Dorosłych – Uwarunkowania Psychologiczne*. Poznań: Bogucki Wydawnictwo Naukowe (2006).
4. Woynarowska B. *Edukacja zdrowotna*. Podrecznik akademicki. Warszawa: Wyd. Naukowe PWN (2007).
5. Parsons T. *Struktura Społeczna a Osobowość*. Warszawa: PWE (1969).
6. Bishop GD. *Psychologia Zdrowia*. Astrum: Wyd. Wrocław (2000).
7. Heszen I. Duchowość i jej rola w radzeniu sobie ze stresem. In: Suchocka L, Sztembis R, editors. *Człowiek i dzieło*. Lublin: Wyd. KUL (2010), p. 215–23.
8. Antonovsky A. *Rozwikłanie Tajemnicy Zdrowia*. Warszawa: Fundacja IPN (1996).
9. Heszen I, Sek H. *Psychologia Zdrowia*. Warszawa: PWN (2007).
10. Fries JF. Reducing disability in older age. *J Am Med Assoc.* (2002) 288:3164–66. doi: 10.1001/jama.288.24.3164
11. Fishbein M, Triandis HC, Kanfer FH, Becker M, Middlestadt SE, Eichler A. Factors influencing behavior and behavior change. In Baum A, Revenson TA, Singer JE, editors. *Handbook of Health Psychology*. Mahwah, NJ: Lawrence Erlbaum Associates (2001), p. 3–18.
12. Juczyński Z. *Narzedzia Pomiaru w Promocji i Psychologii Zdrowia*. Warszawa: Wyd. Pracownia Testów Psychologicznych (2011).
13. *Wpływ Pandemii na Zachowania Zdrowotne Polaków*. I edycja, Raport IBris (2020). Available online at: https://ibris.pl/wp-content/uploads/2020/04/RAPORT-IBRiS_Wp%C5%82yw-pande mii-na-zachowania-zdrowotne-Polak%C3%B3w-wybrane-wyniki.pdf (accessed April 4, 2022).
14. Sidor A, Rzymski P. Dietary choices and habits during COVID-19 lockdown: experience from Poland. *Nutrients.* (2020) 12:1657. doi: 10.3390/nu12061657
15. Ammar A, Brach M, Trabelsi K, Chtourou H, Boukhris O, Masmoudi L, et al. Effects of COVID-19 home confinement on eating behaviour and physical activity: results of the ECLB-COVID19 International Online Survey. *Nutrients.* (2020) 12:1583. doi: 10.1159/000512852
16. Wypych-Slusarska A, Grot M, Nigowski M. Zachowania majace na celu wzmocnienie odporności w okresie pandemii COVID-19. *Med Srod.* (2021) 24:5–10. doi: 10.26444/ms/142528
17. Caputo E, Reichert F. Studies of physical activity and COVID-19 during the pandemic: a scoping review. *J Phys Act Health.* (2020) 17:1275–84. doi: 10.1123/jpah.2020-0406
18. Lesser I, Nienhuis C. The impact of COVID-19 on physical activity behavior and well-being of Canadians. *Int J Environ Res Public Health.* (2020) 17:3899. doi: 10.3390/ijerph17113899
19. *Aktywność fizyczna Polaków wymaga wsparcia, Badania MultiSport Index 2020.* Warszawa (2020)
20. Kantar. *MultiSport Index 2020: Aktywność fizyczna Polaków wymaga wsparcia.* Grudzień (2020). Avaialble onlie at: https://www.benefitsystems.pl/o-nas/biuro-prasowe/raport/?tx_news_pi1%5Bnews%5D=7051&tx_news_pi1%5Bcontroller%5D=News&tx_news_pi1%5Baction%5D=detail&cHash=70f20f28c37ac38ccf45a895a173cda7(accessed April 04, 2022).
21. Sonza A, da Cunha de Sá-Caputo D, Sartorio A, Tamini S, Seixas A, Sanudo B, Süßenbach J, Provenza MM, Xavier VL, Taiar R, Bernardo-Filho M. COVID-19 lockdown and the behavior change on physical exercise, pain and psychological well-being: an international multicentric study. *Int J Environ Res Public Health.* (2021) 18:3810. doi: 10.3390/ijerph18073810
22. Kim SB, Jeong IS. Social determinants related to COVID-19 infection. *Nurs Health Sci.* (2022) 24:499–507. doi: 10.1111/nhs.12947
23. Tuakli-Wosornu YA, Pandiyan U, Stratton C, Hwang Y, Hajjioui A, Muñoz-Velasco LP, et al. Perceived physical and mental health and healthy eating habits during the COVID-19 pandemic in Korea. *J Korean Med Sci.* (2022) 37:e118. doi: 10.3346/jkms.2022.37.e118
24. Souza LFF, Paineiras-Domingos LL, Melo-Oliveira MES, Pessanha-Freitas J, Moreira-Marconi E, Lacerda ACR, et al. The impact of COVID-19 pandemic in the quality of sleep by Pittsburgh Sleep Quality Index: a systematic review. *Cien Saude Colet.* (2021) 26:1457–66. doi: 10.1590/1413-81232021264.459 52020
25. Sonza A, Da Cunha de Sá-Caputo D, Bachur JA, Rodrigues de Araújo MDG, Valadares Trippo KVT, Ribeiro Nogueira da Gama DRNDG, et al. Brazil before and during COVID-19 pandemic: impact on the practice and habits of physical exercise. *Acta Biomed.* (2020) 92:e2021027. doi: 10.23750/abm.v92i1.10803
26. Melo-Oliveira ME, Sá-Caputo D, Bachur JA, Paineiras-Domingos LL, Sonza A, Lacerda AC, et al. Reported quality of life in countries with cases of COVID19: a systematic review. *Expert Rev Respir Med.* (2021) 15:213–20. doi: 10.1080/17476348.2021.1826315
27. Galli F, Giancamilli F, Palombi T, Vitale JA, Borghi S, De Maria A, et al. Anxiety, motives, and intention for physical activity during the Italian COVID-19 lockdown: an observational longitudinal study. *Int J Environ Res Public Health.* (2022) 19:4689. doi: 10.3390/ijerph19084689
28. De Maio M, Bratta C, Iannaccone A, Castellani L, Foster C, Cortis C, et al. Home-based physical activity as a healthy aging booster before and during COVID-19 outbreak. *Int J Environ Res Public Health.* (2022) 19:4317. doi: 10.3390/ijerph19074317

High-risk population's knowledge of risk factors and warning symptoms and their intention toward gastric cancer screening in Southeastern China

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Background: As the incidence of gastric cancer (GC) increases sharply in
adults aged over 40 years, screening of this high-risk population is important.
This study aimed to explore knowledge level of GC related risk factors and
symptoms, and to identify influencing factors associated with intention toward
GC screening among people aged 40 years old and above in China.

Methods: A cross-sectional, web-based survey was conducted among
people aged 40 years old and above between October 2021 and March
2022 in Southeastern China. The participants' knowledge was assessed by a
series of questions about risk factors (24-item scale) and warning symptoms
(14-item scale).

Results: A total of 2547 complete responses were received. The mean age was
47.72 ($\pm$7.20) years and near 60% were male. Respondents had a moderate
level of knowledge about risk factors and warning symptoms of GC. The total
mean knowledge score was 23.9 ($\pm$9.8) out of a possible score of 38. Majority
(80%) of respondents reported intention to be screened for GC in the next
5 years. The most influential predictors of screening intention were income
level (OR = 2.13, 95% CI: 1.36−3.32), perceived benefits (OR = 1.99, 95%
CI: 1.33−2.73), perceived severity (OR = 1.68, 95% CI: 1.20−2.34), ever took
GC screening (OR = 1.63, 95% CI: 1.28−2.08), perceived poor overall health
(OR = 1.59, 95% CI: 1.19−2.11), and perceived barriers (OR = 1.56, 95% CI:
1.17−2.09). Other significant factors were ever diagnosed with chronic gastric
diseases, total knowledge score, and cues-to-action. The major reasons for
not willing to take screening were "endoscopy is uncomfortable" (29.6%),
"worry about screening results" (23.6%), and "have no symptoms" (21.3%).

Conclusion: High-risk population aged 40 years and above expressed high intention to receive GC screening. Intervention to improve health promotion and reduce the barriers to uptake of GC screening among high-risk populations in China is warranted.

Introduction

Gastric cancer (GC) remains an important cancer worldwide and is responsible for over one million new cases in 2020 and an estimated 769,000 deaths (1). Eastern Asia and Central and Eastern Europe are regions with the highest incidence rate of GC in the world (2). In China, although the incidence and mortality have slightly decreased in the past two decades, high burden of GC still persists (3). The incidence and mortality rates of GC in China account for a staggering near 50% of the global burden (3, 4). GC is often asymptomatic in early stage, and the majority of patients were diagnosed with advanced stage, usually after they seek medical advice due to symptoms present (5). Likewise in China, more than 90% (6) of GC patients in clinics were presented at an advanced stage, in which the 5-year survival rate was only 35.1% (7). In contrast, the 5-year survival rate of patients with early GC after treatment exceeds 90% and can even be cured (8, 9).

Early detection of GC has great potential to improve survival and reduce disease mortality. Endoscopic screening for GC in moderate to high risk populations was found to be cost-effective (10), and it had been implemented in many countries with high incidence of GC (11, 12). Because the incidence of GC sharply increases after 40 years of age, regular screening is recommended for this target population in countries with high incidence of GC, such as Korea, Japan and China. The 5-year survival rate of GC is significantly lower in China than that of Japan and Korea (13), suggesting diagnosis delays among Chinese patients (14). Differences in screening rate coverage might partly explain the intercountry discrepancies of diagnosis delays. In Korea, National Cancer Screening Program (NCSP) has been initiated since 1999 to provide GC screening for patients 40 years or older every 2 years at no charge or 10% co-payment, depending on their insurance or income stratum (15). Upon implementation of GC screening program, screening rate in Korean has increased from 7.5% in 2002 to 47.3% in 2012 (16). As a result, more than 50% of GC in Korea were diagnosed at an early stage, compared to fewer than 10% in Western countries and China (17). Despite the serious burden of GC, there are no nationwide screening programs in China (14). Opportunistic screening with endoscopy in asymptomatic people is the primary practice in China (18). Compared with organized screening, opportunistic screening involves fewer formal decisions about whether to screen, whom to screen and at what intervals screening should be done (19). In 2005, China launched National Key Public Health Projects, and provided free endoscopic screenings for upper gastrointestinal cancer in more than 110 high-risk areas throughout the country. However, the estimated compliance rate (33.5%) was low (20). The national GC screening rate is still unknown in China. According to a recent cross-sectional study, the ever-screening rate of GC among adult Chinese was only 15.2% (21).

Similar to many countries worldwide, China has faced many obstacles in the introduction of GC screening, such as lack of knowledge related to GC and screening, high cost of screening, and negative attitude toward screening (21). GC is a multifactorial, multistep process (22). Host factors include blood group A, pernicious anemia, prior gastric surgery, family history, hereditary diffuse GC, and genetic syndromes. Smoking, salt, salty and smoked food, red meat, obesity, and low socioeconomic status are environmental factors. Moreover, infection with *Helicobacter pylori* and Epstein–Barr virus also play a role in gastric carcinogenesis (22, 23). Information on these risk factors helps characterize individuals at risk of GC during their lifetime and promote health-related behavior change. A recent survey from Korea (24) demonstrated that people with lower perceived risk of GC are less likely to take screening. This may primarily due to the fact that knowledge of the risk factors is a vital aspect in developing cancer risk perceptions and further influencing the participation in cancer screening (25, 26). In addition, knowledge about warning symptoms is critical for patients' timely medical care-seeking behavior. A recent study showed that knowledge about warning symptoms can lead to earlier presentation to medical care, which could result in earlier diagnosis and better outcomes (27). The presence of an abdominal lump, abdominal fullness and pain are typical warning symptoms of GC (28), which are easily mistaken as mild gastrointestinal disease. Economic problem was also suggested as a significant barrier. People in the lowest income level were less likely to undergo GC screening (21). Furthermore, negative attitudes toward GC screening, such as fear of screening procedure, fear of finding tumor, may also cause ignorance about screening (21, 29).

Fujian province, located in Southeastern part of China, is a well-known high-risk region of GC in China with higher incidence rate than the average national level (33.1/100,000 vs. 30.0/100,000) (30). Several cities in Fujian province have reported a 2-fold higher mortality rate than the national average level (49.47/100,000 vs. 21.9/100,000) (31). According to expert consensus in China, individuals aged at least 40 years from high-risk regions can be grouped as high-risk population of GC and regular screenings are recommended (6). To the best of our knowledge, no study on GC screening intention was carried out in high-risk population of China. Thus, the current study mainly aimed to investigate knowledge level of GC risk factors and symptoms as well as intention toward screening in Fujian province of China. Accurate information on factors associated with screening behaviors has important implications for health-related behavior change and may strengthen GC prevention and control.

Methods

Study design and participants

We commenced a cross-sectional, web-based anonymous survey using an online questionnaire during October 2021 and March 2022. Convenience sampling was conducted to recruit subjects for this study. The research team used WeChat (the most popular social media platform in China) to advertise and circulate the survey link to their network members. Network members were requested to distribute the survey invitation to all their contacts that satisfy the inclusion criteria. The inclusion criteria were that (1) aged 40 years and above; (2) living in Fuzhou, Putian, Quanzhou, Xiamen, and Zhangzhou city of Fujian province; (3) having no history of cancer. Upon completing the survey, each respondent providing a valid questionnaire was awarded an incentive of 5 Chinese Yuan (equivalent to 0.75 USD). In an attempt to reach a more comprehensive recipient coverage, we also encouraged participants to disseminate the survey link to all their contacts with a thank you note at the end. The participants were informed that their participation was voluntary, and consent was implied through their completion of the questionnaire. The reason for selecting these five cities was due to they are the major cities with the highest incidence of GC in Fujian Province. In total, the accumulated population of these five cities accounts for 73.43% of the total population in Fujian province (32).

Instrument

The questionnaire was self-developed and pilot tested. Local experts of both epidemiologists and clinicians validated the content of the questionnaire. The survey consisted of four sections, which mainly assessed (1) demographic and general health; (2) knowledge about GC-related risk factors and warning symptoms; (3) history of treatment-seeking, and (4) attitudes and intention toward GC screening.

Demographic and general health

The first section of the questionnaire assessed participants' demographic characteristics such as age, gender, height, weight, highest education level, marital status, current residing location (urban/rural), current residing city, occupational types, and monthly average income. Participants were also asked if they ever knew any first-degree relatives, or any friends, neighbors, or colleagues who have been diagnosed with GC. For general health status, participants were asked if they "*Ever diagnosed with chronic gastric diseases (e.g., chronic gastritis, gastric ulcer, etc.)*", perceived overall health, smoking, alcohol drinking, health insurance, and if they ever took GC screening.

Knowledge

The participants' knowledge was assessed by a series of questions about risk factors (24-item scale) and warning symptoms (14-item scale). The response options were "true," "false," or "don't know." A correct response was given a score of one, and an incorrect or "don't know" response was scored zero. The total possible knowledge scores ranged from 0 to 38, with higher scores representing higher levels of knowledge. The median score was used to divide participants into high or low knowledge groups.

Attitudes

Health beliefs about GC screening was measured using the constructs from the Health Belief Model (HBM) (33). The questions probed perceived susceptibility to GC (three items), perceived severity of GC (three items), perceived benefits of GC screening (two items), perceived barriers to conduct GC screening (five items), and cues-to-action (three items). Perceived susceptibility queried participants about (1) general risk of a person having GC in their lifetime; (2) general risk of a person contracting *Helicobacter Pylori* in their lifetime, and (3) their own perceived risk of having GC. Perceived severity assessed participants' perception of harm of GC. Questions evaluating perceived benefits queried participants their views about the benefit of GC screening in early diagnosis and treatment of GC, and prognosis. Perceived barriers to conduct GC screening explored participants' concerns/hesitations when thinking of having screening. Cues-to-action questioned participants about motivation to conduct screening. The response options were "strongly agree," "agree," "disagree," and "strongly disagree."

A four-point scale was also used for questions about participants' intention to take GC screening in the next 5 years, namely "certainly yes," "probably yes," "probably no," and "certainly no." The domain reason for not being willing to take screening was also queried. Respondents were also requested to report their preferences of screening method by selecting one of the following options: "endoscopy," "blood test," "fecal examination," and "none of them."

Sample size calculation

The minimal sample size was calculated based on the formula $N = [\mu_{\alpha/2}^2 \times \pi \times (1-\pi)]/\delta^2$. The prevalence rate was 15% (π) based on the GC screening rate reported in the previous study [21], with a significant level set to be 0.05 (α), and allowable error as 0.03 (δ). The estimated minimal sample size was 544. In consideration of non-response rate, invalid questionnaire of 40%, a final target sample of 800 was determined.

Statistical analyses

The reliability of the knowledge score was evaluated by assessing the internal consistency of the items representing the knowledge scores. Multivariable logistic regression was used to determine the factors influencing screening intention. All factors found to be statistically significant (p-value < 0.05) in the univariate regression analysis were entered into multivariable logistic regression analyses using a simultaneous forced-entry method. Odds ratio (OR), 95% confidence interval (95% CI) and p-values were calculated for each independent variable. The model fit of multivariable logistic regression analysis was assessed using the Hosmer-Lemeshow goodness-of-fit test [34]. All p-values are based on a two-sided test with a statistical test level of α set at 0.05. All statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS), version 26.0.

Ethics and permission for data collection

Following the standards of Helsinki Declaration and its corresponding modifications or similar ethical principles, this study was carried out. The data was collected through an online survey where written informed consent was taken from each participant. Respondents who expressed their consent, after reading the aforementioned, to take part in the study by clicking either "Yes" or "No" were included in the study. Those who did not consent by clicking "No" were not included in the study. Ethics approval and permission for data collection were granted by the Medical Ethics Committee at the Fujian Medical University (FJMU No. 2020 [53]).

Results

Demographics characteristics of the participants

Between October 2021 and March 2022, a total of 2,547 completed responses were received. Supplementary Table 1

TABLE 1 Demographic characteristics of respondents ($N = 2,547$).

Characteristic	No.	%
Age, mean ± SD	47.72 ± 7.20	
Age groups		
40–50	1,991	78.2
51–60	408	16.0
>60	148	5.8
Body mass index (kg/m²)		
<18.5	175	6.9
18.5–24.9	1,882	73.9
≥25.0	490	19.2
Sex		
Male	1,522	59.8
Female	1,025	40.2
Educational level		
Secondary school and below	849	33.3
High school/technical school	894	35.1
University and above	804	31.6
Monthly average income (RMB)*		
<2,000	291	11.4
2,000–5,000	1,034	40.6
>5,000	1,222	48.0
Current residing location		
Urban	1,448	56.9
Rural	1,099	43.1
Current residing region		
Fuzhou city	699	27.4
Putian city	425	16.7
Xiamen city	559	21.9
Zhangzhou city	430	16.9
Quanzhou city	434	17.1
Occupation		
Professional and managerial	632	24.8
Office worker/service personnel	432	17.0
Industrial worker/Farmers/Others	770	30.2
Individual business/self-employed	443	17.4
Housewife/retired/unemployed	270	10.6

* 1 RMB = 0.15 USD.

FIGURE 1
Percentages of correct responses to knowledge items (*N* = 2,547).
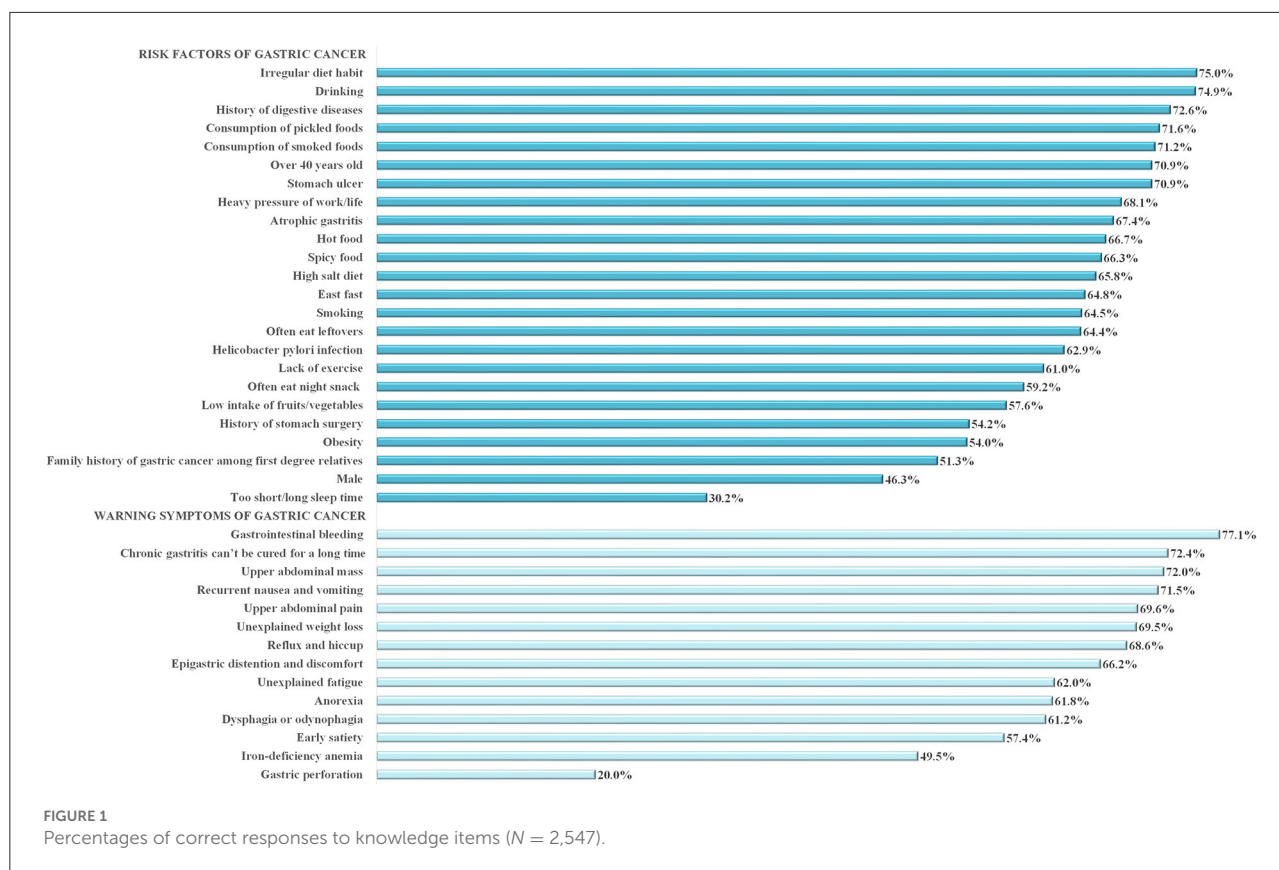
shows the demographics of our study participants compared with the adults aged 40 years and older population in Fujian. A summary of the characteristics of the participants is provided in the Table 1 and second column of Table 3. The mean age of study participants was 47.72 years (±7.20). A large proportion of participants were aged 40–50 years (78.2%). Near half of the participants lived in urban (56.9%) and had monthly average income > 5,000 RMB (750 USD) (48.0%). The highest education level is distributed nearly even in secondary school and below (33.3%), high school/technical school (35.1%), and university and above (31.6%). Only 18.8% of participants reported first-degree relatives had GC, while 40.6% were aware of their friends, neighbor, or colleagues had ever been diagnosed with GC. A total of 40.0% of participants reported a history of chronic gastric disease and 42.6% ever took GC screening.

Knowledge about risk factor and warning symptoms of gastric cancer

Figure 1 and Table 2 show the proportion of correct responses to all 38 knowledge items (24 items of risk factors and 14 items of warning symptoms). The 38 items for knowledge scores had a reliability (Cronbach's α) of 0.954. The mean

and standard deviation (SD) for the total knowledge score was 23.9 (SD ± 9.8) out of a possible score of 38. The median was 25 (interquartile range, IQR, 17–33). Knowledge scores were categorized high or low based on median split; as such, a total of 1,209 (47.5%) were categorized as having a high score (25 to 38) and 1,338 (52.5%) had a low score (0–24).

The most highly recognized risk factors were "irregular diet habit" (75.0%), and "alcohol drinking" (74.9%), followed by "history of digestive disease" (72.6%), "consumption of pickled food" (71.6%), "consumption of smoked food" (71.2%), "aged 40 years and above" (70.9%), and "stomach ulcer" (70.9%). The least recognized risk factor was "male" (46.3%). In particular, only 56.7% of male respondents (data not shown) were aware of this inherent risk. Meanwhile, majority of participants wrongly regarded "too short/long sleeping time" (55.0%) as a risk factor of GC. The most highly recognized warning symptoms were "gastrointestinal bleeding" (77.1%), followed by "chronic gastritis can't be cured for a long time" (72.4%), "upper abdominal pain" (72.0%) and "recurrent nausea and vomiting" (71.5%). The least recognized warning symptoms were "early satiety" (57.4%) and "hypoferric anemia" (49.5%), while 70.2% of respondents wrongly considered "gastric perforation" (70.2%) as a warning symptom.

TABLE 2 Respondents' knowledge about risk factors and warning symptoms of gastric cancer.

Category	Yes, *n* (%)	No, *n* (%)	Don't know, *n* (%)
Risk factors of gastric cancer			
Aged 40 years and over	1,806 (70.9)	390 (15.3)	351 (13.8)
Male	1,178 (46.3)	848 (33.3)	521 (20.5)
Helicobacter pylori infection	1,603 (62.9)	467 (18.3)	477 (18.7)
Stomach ulcer	1,806 (70.9)	463 (18.2)	278 (10.9)
Atrophic gastritis	1,716 (67.4)	505 (19.8)	326 (12.8)
Family history of gastric cancer among first degree relatives	1,306 (51.3)	902 (35.4)	339 (13.3)
High salt diet	1,677 (65.8)	582 (22.9)	288 (11.3)
Consumption of pickled foods	1,824 (71.6)	534 (21.0)	189 (7.4)
Consumption of smoked foods	1,813 (71.2)	550 (21.6)	184 (7.2)
Irregular diet habit	1,910 (75.0)	488 (19.2)	149 (5.9)
Often eat leftovers	1,639 (64.4)	668 (26.2)	240 (9.4)
Smoking	1,644 (64.5)	634 (24.9)	269 (10.6)
Alcohol drinking	1,907 (74.9)	464 (18.2)	176 (6.9)
High pressure of work/life	1,734 (68.1)	547 (21.5)	266 (10.4)
Often eat night snack	1,507 (59.2)	738 (29.0)	302 (11.9)
Lack of exercise	1,553 (61.0)	669 (26.3)	325 (12.8)
Low intake of fruits/vegetables	1,468 (57.6)	806 (31.6)	273 (10.7)
Too short/long sleep time	1,401 (55.0)	768 (30.2)	378 (14.8)
Obesity	1,375 (54.0)	801 (31.4)	371 (14.6)
History of digestive diseases	1,848 (72.6)	522 (20.5)	177 (6.9)
History of stomach surgery	1,381 (54.2)	899 (35.3)	267 (10.5)
Consumption of spicy food	1,689 (66.3)	636 (25.0)	222 (8.7)
Consumption of hot food	1,700 (66.7)	634 (24.9)	213 (8.4)
East fast	1,650 (64.8)	616 (24.2)	281 (11.0)
Warning symptoms of gastric cancer			
Gastrointestinal bleeding	1,965 (77.1)	398 (15.6)	184 (7.2)
Recurrent nausea and vomiting	1,821 (71.5)	469 (18.4)	257 (10.1)
Unexplained weight loss	1,770 (69.5)	514 (20.2)	263 (10.3)
Unexplained fatigue	1,579 (62.0)	603 (23.7)	365 (14.3)
Epigastric distention and discomfort	1,685 (66.2)	527 (20.7)	335 (13.2)
Upper abdominal mass	1,834 (72.0)	430 (16.9)	283 (11.1)
Upper abdominal pain	1,772 (69.6)	475 (18.6)	300 (11.8)
Anorexia	1,573 (61.8)	626 (24.6)	348 (13.7)
Dysphagia or odynophagia	1,559 (61.2)	679 (26.7)	309 (12.1)
Early satiety	1,461 (57.4)	702 (27.6)	384 (15.1)
Reflux and hiccup	1,746 (68.6)	512 (20.1)	289 (11.3)
Chronic gastritis can't be cured for a long time	1,845 (72.4)	459 (18.0)	243 (9.5)
Iron-deficiency anemia	1,260 (49.5)	798 (31.3)	489 (19.2)
Gastric perforation	1,788 (70.2)	509 (20.0)	250 (9.8)

Gastric cancer screening intention and its influencing factors

Figure 2 shows the proportions of intention to take screening in the next 5 years. In total, 80.0% (*n* = 2,038) of participants reported "certainly yes/probably yes" and 20.0%

(*n* = 509) reported "certainly no/probably no" regarding their intention to screen in the next 5 years (Figure 2).

Results of univariate and multivariable logistic regression were presented in Table 3. Multivariable logistic regression showed that monthly income > 5,000 RMB (OR = 2.13, 95% CI: 1.36–3.32) was the most robust factor associated with screening

TABLE 3 Factors associated with intention to take gastric cancer screening in the next 5 years (N = 2,547).

	Frequency (%)	Univariate analysis			p-value	Multivariable logistic regression*	p-value
		Intention				Yes vs. No	
		Yes n = 2,038	No n = 509	Unadjusted OR (95% CI)		OR (95% CI)	
Baseline demographic							
Age group (years old)							
40–50	1,991 (78.2)	1,616 (81.2)	375 (18.8)	2.01(1.39–2.89)	0.001	1.36 (0.84–2.21)	0.206
51–60	408 (16.0)	321 (78.7)	87 (21.3)	1.72 (1.13–2.61)		1.24 (0.75–2.05)	0.404
>60	148 (5.8)	101 (68.2)	47 (31.8)	Reference		Reference	
Sex							
Male	1,522 (59.8)	1,209 (79.4)	313 (20.6)	0.91 (0.75–1.12)	0.372		
Female	1,025 (40.2)	829 (80.9)	196 (19.1)	Reference			
Body mass index (kg/m^2)							
<18.5	175 (6.9)	135 (77.1)	40 (22.9)	0.88 (0.58–1.33)	0.538		
18.5–24.9	1,882 (73.9)	1,514 (80.4)	368 (19.6)	1.07 (0.84–1.37)			
≥25.0	490 (19.2)	389 (79.4)	101 (20.6)	Reference			
Highest education level							
Primary school and below	283 (11.1)	197 (69.6)	86 (30.4)	Reference	p < 0.001	Reference	
Secondary school	566 (22.2)	450 (79.5)	116 (20.5)	1.69 (1.22–2.35)		0.93 (0.60–1.46)	0.762
High school/technical school	894 (35.1)	729 (81.5)	165 (18.5)	1.93 (1.42–2.62)		1.33 (0.92–1.91)	0.129
University and above	804 (31.6)	662 (82.3)	142 (17.7)	2.04 (1.49–2.78)		1.05 (0.78–1.42)	0.759
Marital status							
Married	2,240 (87.9)	1,821 (81.3)	419 (18.7)	1.80 (1.38–2.36)	p < 0.001	1.30 (0.92–1.83)	0.136
Unmarried/divorced/separated/widowed	307 (12.1)	217 (70.7)	90 (29.3)	Reference		Reference	
Current residing location							
Urban	1,448 (56.9)	1,180 (81.5)	268 (18.5)	1.24 (1.02–1.50)	0.033	0.86 (0.67–1.09)	0.212
Rural	1,099 (43.1)	858 (78.1)	241 (21.9)	Reference		Reference	
Current residing region							
Fuzhou city	699 (27.4)	562 (80.4)	137 (19.6)	0.97 (0.72–1.31)	0.004	0.79 (0.56–1.11)	0.116
Putian city	425 (16.7)	344 (80.9)	81 (19.1)	1.00 (0.72–1.41)		1.41 (0.94–2.13)	0.098
Xiamen city	559 (21.9)	465 (83.2)	94 (16.8)	1.17 (0.84–1.62)		0.91 (0.64–1.31)	0.621

(Continued)

TABLE 3   Continued

	Frequency (%)	Univariate analysis			p-value	Multivariable logistic regression*	p-value
		Intention				Yes vs. No	
		Yes n = 2,038	No n = 509	Unadjusted OR (95% CI)		OR (95% CI)	
Zhangzhou city	430 (16.9)	316 (73.5)	114 (26.5)	0.66 (0.48–0.90)		0.79 (0.55–1.12)	0.186
Quanzhou city	434 (17.0)	351 (80.9)	83 (19.1)	Reference		Reference	
Occupation							
Professional and managerial	632 (24.8)	519 (82.1)	113 (17.9)	1.83 (1.31–2.59)	p < 0.001	0.86 (0.53–1.40)	0.554
Office worker/Service personnel	432 (17.0)	371 (85.9)	61 (14.1)	2.43 (1.67–3.54)		1.22 (0.75–2.01)	0.425
Industrial worker /Farmers/Others	770 (30.2)	592 (76.9)	178 (23.1)	1.33 (0.97–1.81)		0.89 (0.59–1.35)	0.580
Individual business/ Self-employed	443(17.4)	363 (81.9)	80 (18.1)	1.81 (1.27–2.59)		0.98 (0.61–1.58)	0.930
Housewife/Retired/Unemployed	270(10.6)	193 (71.5)	77 (28.5)	Reference		Reference	
Monthly average income (RMB)							
<2,000	291 (11.4)	189 (64.9)	102 (35.1)	Reference	p < 0.001	Reference	
2,000–5,000	1,034 (40.6)	827 (80.0)	207 (20.0)	2.16 (1.62–2.87)		1.70 (1.15–2.50)	0.008
>5,000	1,222 (48.0)	1,022 (83.6)	200 (16.4)	2.76(2.08–3.67)		2.13 (1.36–3.32)	0.001
Experience with gastric cancer							
Ever known any first-degree relatives has had gastric cancer							
Yes	479 (18.8)	406 (84.8)	73 (15.2)	1.49 (1.13–1.95)	0.004	1.05 (0.76–1.45)	0.772
No	2,068 (81.2)	1,632 (78.9)	436 (21.1)	Reference		Reference	
Ever known any friends, neighbor, colleagues have had gastric cancer							
Yes	1,033 (40.6)	878 (85.0)	155 (15.0)	1.73 (1.40–2.13)	p < 0.001	1.09 (0.85–1.40)	0.483
No	1,514 (59.4)	1,160 (76.6)	354 (23.4)	Reference		Reference	
Health characteristics							
Ever diagnosed with chronic gastric diseases (e.g., chronic gastritis, gastric ulcer, etc.)							
Yes	1,020 (40.0)	872 (85.5)	148 (14.5)	1.82 (1.48–2.25)	p < 0.001	1.30 (1.01–1.68)	0.041
No	1,527 (60.0)	1,166 (76.4)	361 (23.6)	Reference		Reference	
Perceived overall health							
Very good	429 (16.8)	317 (73.9)	112 (26.1)	Reference	p < 0.001	Reference	
Good	697 (27.4)	546 (78.3)	151 (21.7)	1.28 (0.97–1.69)		1.10 (0.81–1.50)	0.542
Fair/poor/very poor	1,421 (55.8)	1,175 (82.7)	246 (17.3)	1.69 (1.31–2.18)		1.59 (1.19–2.11)	0.002

(Continued)

TABLE 3 Continued

	Frequency (%)	Univariate analysis			p-value	Multivariable logistic regression*	p-value
		Intention				Yes vs. No	
		Yes n = 2,038	No n = 509	Unadjusted OR (95% CI)		OR (95% CI)	
Smoking							
Yes	829 (32.5)	682 (82.3)	147 (17.7)	1.24 (1.00–1.53)	0.049	1.05 (0.82–1.34)	0.696
No	1,718 (67.5)	1,356 (78.9)	362 (21.1)	Reference		Reference	
Alcohol drinking							
Yes	627 (24.6)	505 (80.5)	122 (19.5)	1.05 (0.83–1.31)	0.704		
No	1,920 (75.4)	1,533 (79.8)	387 (20.2)	Reference			
Health insurance							
Yes	2,276 (89.4)	1,850 (81.3)	426 (18.7)	1.92 (1.45–2.53)	p < 0.001	1.16 (0.82–1.34)	0.403
No	271 (10.6)	188 (69.4)	83 (30.6)	Reference		Reference	
Ever took gastric cancer screening							
Yes	1,086 (42.6)	943 (86.8)	143 (13.2)	2.20 (1.78–2.73)	p < 0.001	1.63 (1.28–2.08)	p < 0.001
No	1,461 (57.4)	1,095 (74.9)	366 (25.1)	Reference		Reference	
Knowledge of risk factors and warning symptoms							
Total knowledge score							
Low score (0–24)	1,209 (47.5)	889 (73.5)	320 (26.5)	Reference	p < 0.001	Reference	
High score (25–38)	1,338 (52.5)	1,149 (85.9)	189 (14.1)	2.19 (1.79–2.67)		1.46 (1.16–1.84)	0.001
Health beliefs							
Perceived susceptibility							
In general, a person has a high risk of having gastric cancer in their lifetime					p < 0.001		
Strongly agree/agree	1,410 (55.4)	1,199 (85.0)	211 (15.0)	2.02 (1.66–2.46)		1.44 (1.11–1.85)	0.005
Disagree/strongly disagree	1,137 (44.6)	839 (73.8)	298 (26.2)	Reference		Reference	
I may have gastric cancer							
Strongly agree/agree	967 (38.0)	833 (86.1)	134 (13.9)	1.94 (1.60–2.40)	p < 0.001	1.17 (0.90–1.52)	0.247
Disagree/strongly disagree	1,580 (62.0)	1,205 (76.3)	375 (23.7)	Reference		Reference	
In general, a person has a high risk of infecting *Helicobacter pylori* infection in their lifetime							
Strongly agree/agree	1,676 (65.8)	1,404 (83.8)	272 (16.2)	1.93 (1.58–2.35)	p < 0.001	0.91 (0.70–1.19)	0.491
Disagree/strongly disagree	871 (34.2)	634 (72.8)	237 (27.2)	Reference		Reference	

(Continued)

TABLE 3 Continued

	Frequency (%)	Univariate analysis			p-value	Multivariable logistic regression*	p-value
		Intention				Yes vs. No	
		Yes n = 2,038	No n = 509	Unadjusted OR (95% CI)		OR (95% CI)	
Perceived severity							
Harms of gastric cancer are severe							
Strongly agree/agree	2,273 (89.2)	1,870 (82.3)	403 (17.7)	2.93 (2.24–3.82)	p < 0.001	0.98 (0.64–1.48)	0.906
Disagree/strongly disagree	274 (10.8)	168 (61.3)	106 (38.7)	Reference		Reference	
Mortality rate of gastric cancer is very high							
Strongly agree/agree	1,995 (78.3)	1,651 (82.8)	344 (17.2)	2.05 (1.65–2.54)	p < 0.001	1.16 (0.87–1.53)	0.309
Disagree/strongly disagree	552 (21.7)	387 (70.1)	165 (29.9)	Reference		Reference	
I am afraid of getting gastric cancer							
Strongly agree/agree	2,172 (85.3)	1,802 (83.0)	370 (17.0)	2.87 (2.26–3.64)	p < 0.001	1.68 (1.20–2.34)	0.002
Disagree/strongly disagree	375 (14.7)	236 (62.9)	139 (37.1)	Reference		Reference	
Perceived benefit							
Screening is highly effective in early diagnosis and early treatment of gastric cancer							
Strongly agree/agree	2,288 (89.8)	1,884 (82.3)	404 (17.7)	3.18 (2.43–4.17)	p < 0.001	1.10 (0.71–1.70)	0.673
Disagree/strongly disagree	259 (10.2)	154 (59.5)	105 (40.5)	Reference		Reference	
Gastric cancer screening highly effective in reducing death rate							
Strongly agree/agree	2,229 (87.5)	1,853 (83.1)	376 (16.9)	3.54 (2.76–4.54)	p < 0.001	1.99 (1.33–2.73)	p < 0.001
Disagree/strongly disagree	318 (12.5)	185 (58.2)	133 (41.8)	Reference		Reference	
Perceived barriers							
I'm afraid screening will find something bad							
Strongly agree/agree	1,772 (69.6)	1,435 (81.0)	337 (19.0)	1.22 (0.99–1.49)	0.065		
Disagree/strongly disagree	775 (30.4)	603 (77.8)	172 (22.2)	Reference			
Screening is only necessary when symptoms present							
Strongly agree/agree	1,442 (56.6)	1,102 (76.4)	340 (23.6)	Reference	p < 0.001	Reference	
Disagree/strongly disagree	1,105 (43.4)	936 (84.7)	169 (15.3)	1.71 (1.39–2.10)		1.29 (1.00–1.65)	0.046
Endoscopy is uncomfortable							
Strongly agree/agree	1,879 (73.8)	1,530 (81.4)	349 (18.6)	Reference	0.003	Reference	
Disagree/strongly disagree	668 (26.2)	508 (76.0)	160 (24.0)	1.38 (1.12–1.71)		1.56 (1.17–2.09)	0.002

(Continued)

TABLE 3 Continued

	Frequency (%)	Univariate analysis				Multivariable logistic regression*	
		Intention			p-value	Yes vs. No	p-value
		Yes n = 2,038	No n = 509	Unadjusted OR (95% CI)		OR (95% CI)	
Cost of endoscopy is very high							
Strongly agree/agree	1,588 (62.3)	1,252 (78.8)	336 (21.2)	0.82 (0.67–1.01)	0.057		
Disagree/strongly disagree	959 (37.7)	786 (82.0)	173 (18.0)	Reference			
It is difficult and time-consuming to have an appointment for endoscopy screening.							
Strongly agree/agree	1,692 (66.4)	1,337 (79.0)	355 (21.0)	0.83 (0.67–1.02)	0.077		
Disagree/strongly disagree	855 (33.6)	701 (82.0)	154 (18.0)	Reference			
Cues-to-action							
I only take screening when it's free							
Strongly agree/agree	1,170 (45.9)	869 (74.3)	301 (25.7)	Reference	p < 0.001	Reference	
Disagree/strongly disagree	1,377 (54.1)	1,169 (84.9)	208 (15.1)	1.95 (1.60–2.37)		1.47 (1.08–2.00)	0.013
I only take screening when it can be covered by medical insurance							
Strongly agree/agree	1,328 (52.1)	1,003 (75.5)	325 (24.5)	Reference	p < 0.001	Reference	
Disagree/strongly disagree	1,219 (47.9)	1,035 (84.9)	184 (15.1)	1.82 (1.49–2.23)		1.24 (0.90–1.70)	0.182
I only take screening when doctor recommends							
Strongly agree/agree	1,804 (70.8)	1,423 (78.9)	381 (21.1)	Reference	0.026	Reference	
Disagree/strongly disagree	743 (29.2)	615 (82.8)	128 (17.2)	1.29 (1.03–1.61)		0.91 (0.67–1.23)	0.530

*Hosmer & Lemeshow test, chi-square: 303.947, P-value: $p < 0.001$; Nagelkerke R^2: 0.178.

intention. Respondents that perceived their own overall health as "fair/poor/very poor" (OR = 1.59, 95% CI: 1.19–2.11), ever took GC screening (OR = 1.63, 95% CI: 1.28–2.08) had more than 50% higher odds of intention to conduct screening. The odds of intention to conduct screening were also higher among respondents who were ever diagnosed with chronic gastric diseases (OR = 1.30, 95% CI: 1.01–1.68), and those had high score of total knowledge (OR = 1.46, 95% CI: 1.16–1.84). Results of HBM indicate that the following five components were significantly associated with screening intention, including perceived susceptibility (risk of getting GC is high, OR = 1.44, 95% CI: 1.11–1.85), perceived severity (afraid of getting GC, OR = 1.68, 95% CI: 1.20–2.34), perceived benefit (GC screening is effective in saving life, OR = 1.99, 95% CI: 1.33–2.73), perceived barriers (endoscopy is uncomfortable, OR = 1.56, 95% CI: 1.17–2.09), and cues-to-action (only take screening when it is free of charge, OR = 1.47; 95% CI: 1.08–2.00).

Reasons for not willing to take gastric cancer screening

The domain reasons for not willing to take screening in the next 5 years are shown in Figure 3. Among respondents who reported probably yes/certainly no/probably no (n = 2,058), the three most common reasons, in descending order,

FIGURE 2
Intention to take gastric cancer screening in the next 5 years (*N* = 2,547).
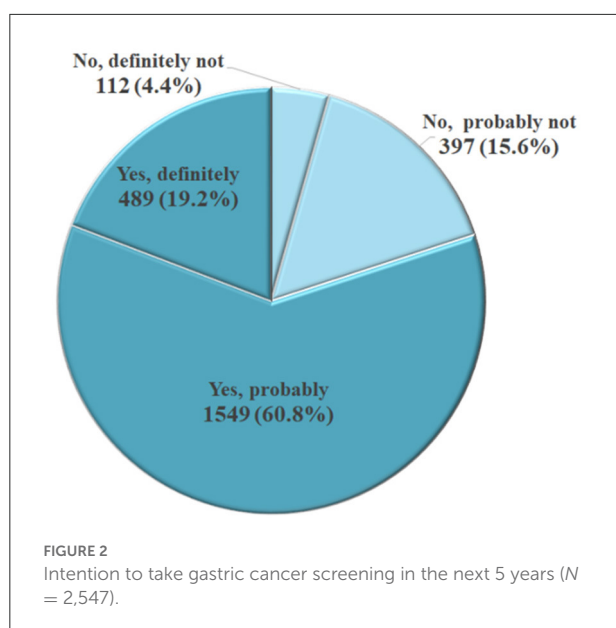
were "endoscopy is uncomfortable" (29.6%), "worried about screening results" (23.6%), and "no symptoms" (21.3%). Other reasons included "no time" (8.3%), "don't know the benefits of screening" (6.9%), "screening cost is too high" (5.5%), and "believe that gastric cancer cannot be cured even detected by screening" (3.4%).

Preferences of screening method

Figure 4 presents respondents' preferences of screening method, grouping by if they ever took GC screening. For those who had ever taken GC screening, the most preferred screening method is endoscopy (52.3%), followed by blood test (35.9%), and fecal examination (10.5%). In contrast, among respondents who never took GC screening, the most favorite screening method was blood test (50.8%), followed by endoscopy (21.5%), and fecal examination (21.3%).

Discussion

To our knowledge, the current study is the first investigation aimed to explore the knowledge level, attitudes to GC screening in high-risk populations in China. In general, the study participants reported a moderate level of knowledge in GC risk factors and warning symptoms. Majority of participants intended to take GC screening in the next 5 years. Significant factors influencing intention to screen were income level, previous history of GC screening or chronic gastric diseases, perceived overall health, total knowledge score, and HBM components (perceived benefit, perceived severity, perceived

barriers, cues to action). "Endoscopy is uncomfortable," "worry about screening results," and "no symptoms" were the domain reasons for not willing to take screening.

Adequate knowledge about risk factors and warning symptoms of GC play an important role in cancer screening and early diagnosis. Poor knowledge about GC has been considered a barrier of GC screening (35). Result of our study also found that participants with high score of knowledge had a 50% increased intention to take GC screening. In 2015, China government implemented a Nationwide Three-Year Cancer Prevention Plan (2015–2017), announcing an ambitious goal to have the public awareness rate of essential cancer knowledge reach 60% (36). Our current study population in Southeastern China has shown a moderate level of knowledge. However, recent studies from other regions of China, including Central and Northeastern China, reported that people still have poor knowledge about GC (21, 37). More importantly, knowledge level varied among different types of risk factors. Specifically, participants were more familiar with life-style related risk factors, such as irregular diet habits, alcohol drinking, consumption of pickled/smoked foods, hot/spicy food, which is in line with a previous study (21). However, some imperative risk factors, such as male gender, family history of GC among first degree relatives were relatively rarely known. Finding from other previous study also identified these were the two least known risk factors (21). It seems that people tend to be more sensitive to those modifiable risk factors, but easily neglect unmodifiable factors such as age and heredity. Future health education program may need to particularly address high-risk populations under exposure to inherent risk factors. On the other hand, the need to improve knowledge about warning symptoms of GC is also clearly shown in the results of this study. In particular, findings indicate that a considerable proportion of surveyed participants lack knowledge of important symptoms such as early satiety and iron-deficiency anemia (IDA). IDA of gastrointestinal cancer origin is particularly common and longstanding due to bleeding. In the preoperative setting, a retrospective review by Jung et al. reported anemia in 43.6% (99/227) of GC patients. Of those, 24.2% (24/99) developed IDA (38). Recognition of warning signs was associated with anticipating faster help-seeking for potential symptoms of cancer (27). Knowing potential warning symptoms of GC may facilitate patients' treatment-seeking behavior.

Insight about demographic factors that facilitate or impede the intention to conduct GC screening may also be critical to promote health-behavior change. Multivariate analysis result of the current study implies that income level was the most robust factor associated with screening intention. High cost of endoscopy was also reported by surveyed participants as one of the major barriers toward screening. Similarly, Shin and Lee in a cross-sectional study reported that as the level of income increases, and the tendency to uptake screening also increases (OR = 1.36, 95% CI: 1.06–1.73) (29). Undoubtedly, affordability plays an important role in screening behavior. In
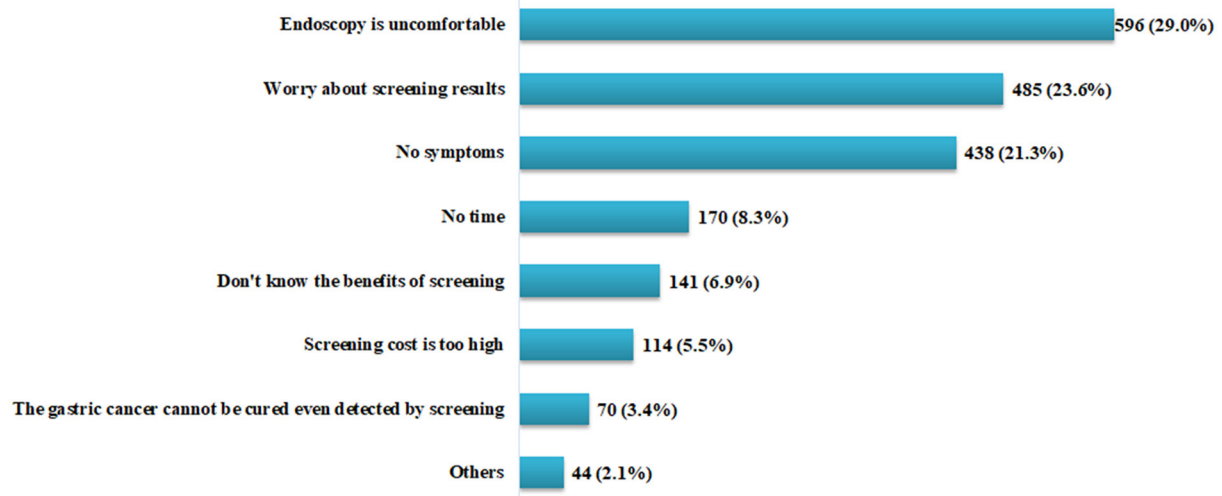
FIGURE 3
Reasons for not willing to have gastric cancer screening in the next 5 years (N = 2,058).
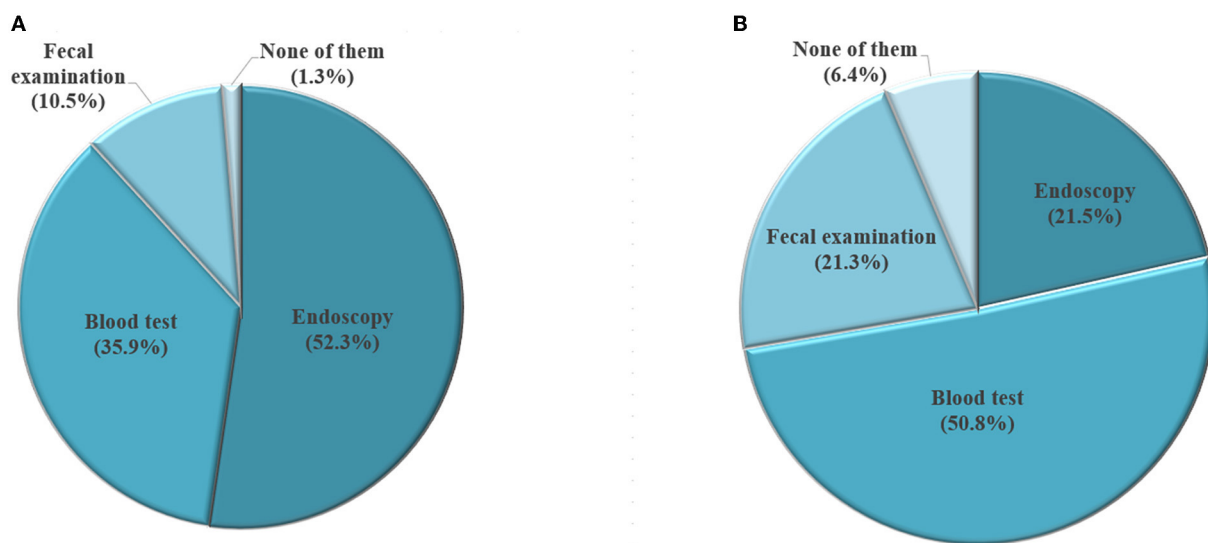
FIGURE 4
Selection of screening method among participants who have had gastric cancer screening (**A**, N = 1,086) and those who haven't had gastric cancer screening (**B**, N = 1,461).

China, endoscopy is conducted *via* opportunistic screening and individual own self is responsible for the related medical cost (39). Japan and Korea are the only two countries in the world that offer nationwide population-based GC screening (40). A Korean study shows that people were likely to intend to receive GC screening if it were offered free of charge or for a copayment (24). Our study also found participants were more likely to take GC screening if it is free of charge. Indeed, the screening rate in Korea has increased from 40.0% in 2005 to 74.8% in 2015

after the introduction of the National Cancer Screening Program which offer free or co-payment screening (41). Establishment of a population-based screening program to guarantee free access to endoscopy, particularly for high-risk populations, would be extremely critical for China and other high-risk regions to increase the early diagnosis rate of GC and consequently reduce the mortality rate.

Analysis results of HBM indicate that the following five components were significantly associated with screening

intention, including perceived susceptibility (risk of getting GC is high), severity (afraid of getting GC), perceived benefit (GC screening is effective in saving life), perceived barriers (is uncomfortable), and cues-to-action (only take screening when it is free of charge). The finding of HBM could be utilized as a theoretical fundamental to design future health promotion program. In particular, discomfort related to endoscopy has been regarded as the most important reason for not being willing to take screening. Meanwhile, the majority of respondents without previous experience with endoscopic screening prioritized blood test for their future screening plan. These results implied that many people fear physical discomfort from the invasive endoscopy procedure. Although China government launched endoscopic screening program since 2005 in more than 110 high-risk areas throughout the country, the compliance rate (33.5%) was found to be low (20). To reduce the public's fear of endoscopy, recognition of its effectiveness for early detection of GC should be emphasized, and more efforts should be addressed to minimize the discomfort associated with the screening procedure. Alternative screening methods other than endoscopy could also be developed and implemented in order to improve the public's willingness to be screened. Furthermore, as *Helicobacter pylori* (a group I carcinogen) has been confirmed to have an important role in gastric carcinogenesis (42), people over 40 years old can be further stratified by *Helicobacter pylori* infection in order to find the most target population for endoscopic screening.

Limitations

This study has several limitations that should be considered. The first pertains to the use of convenience sampling, in which the selection bias could not be eliminated, and its cross-sectional nature. It cannot, therefore, be used to infer causality. Second, data were collected from participants' self-reports; thus, these may be subjected to socially desirable responses. Third, it should be noted that the intention to take screening does not necessarily result in actual receipt of screening; therefore, results should be interpreted with caution. Fourth, the assessment of knowledge was done prior to screening intention, thus may potentially influence participants' responses to screening intentions. A final limitation of this study is that the study population was recruited from five major cities in Fujian province, which may limit generalizability. Despite these limitations, the study data contribute tremendously to the understanding of the influencing factors of GC screening intention in high-risk populations in China.

Conclusions

The present study showed high intention to be screened for GC among high-risk populations aged 40 years and above in China, which is of great importance for a country with low GC screening coverage but high GC burden. Our results imply that economic factor might be the most robust indicator driving respondent's screening intention. To some degree, previous history of gastric diseases and GC screening, perceived overall health status, knowledge level related to GC risk factors and symptoms, and HBM components all contribute to decisions related to future screening intention. Population-based screening program is urgently needed to provide free access to screening, particularly for those high-risk populations. Additionally, continuous education campaigns are needed to improve knowledge of GC risk factors and symptoms in China and to promote the benefits of early cancer diagnosis by screening. Finally, more alternative screening methods other than endoscopy could also be encouraged to improve the general public's willingness to be screened.

Data availability statement

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Ethics statement

The studies involving human participants were reviewed and approved by Medical Ethics Committee at the Fujian Medical University. The patients/participants provided their written informed consent to participate in this study.

Author contributions

ZHua: conceptualization, data curation, formal analysis, investigation, methodology, resources, software, validation, visualization, writing—original draft, and writing—review and editing. WL: data curation, investigation, and writing—review and editing. RM: writing—original draft and writing—review and editing. ZHu and LW: conceptualization, supervision, writing—original draft, and writing—review and editing. YL: conceptualization, data curation, formal analysis, investigation, methodology, resources, software, supervision, validation, visualization, funding acquisition, writing—original draft, and writing—review and editing. All authors contributed to the article and approved the submitted version.

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Conflict of interest

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

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpubh.2022.974923/full#supplementary-material

References

1. Sung H, Ferlay J, Siegel RL, Laversanne M, Soerjomataram I, Jemal A, et al. Global cancer statistics 2020: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. *CA Cancer J Clin.* (2021) 71:209–49. doi: 10.3322/caac.21660

2. Bray F, Ferlay J, Soerjomataram I, Siegel RL, Torre LA, Jemal A. Global cancer statistics 2018: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. *CA Cancer J Clin.* (2018) 68:394–424. doi: 10.3322/caac.21492

3. Chen W, Zheng R, Baade PD, Zhang S, Zeng H, Bray F, et al. Cancer statistics in China, 2015. *CA Cancer J Clin.* (2016) 66:115–32. doi: 10.3322/caac.21338

4. Ferlay J, Soerjomataram I, Dikshit R, Eser S, Mathers C, Rebelo M, et al. Cancer incidence and mortality worldwide: sources, methods and major patterns in GLOBOCAN 2012. *Int J Cancer.* (2015) 136:E359–86. doi: 10.1002/ijc.29210

5. Liu MM, Wen L, Liu YJ, Cai Q, Li LT, Cai YM. Application of data mining methods to improve screening for the risk of early gastric cancer. *BMC Med Inform Decision Mak.* (2018) 18 (Suppl. 5):121. doi: 10.1186/s12911-018-0689-4

6. Du YQ, Cai QC, Liao Z, Fang J, Zhu CP. Expert consensus on early gastric cancer screening procedures in China(draft)(2017,Shanghai). *Chin J Gastroenterol.* (2018) 23:92–7.

7. Zeng H, Chen W, Zheng R, Zhang S, Ji JS, Zou X, et al. Changing cancer survival in China during 2003-15: a pooled analysis of 17 population-based cancer registries. *Lancet Global Health.* (2018) 6:e555–e67. doi: 10.1016/S2214-109X(18)30127-X

8. Ajani JA, Bentrem DJ, Besh S, D'Amico TA, Das P, Denlinger C, et al. Gastric cancer, version 2.2013: featured updates to the NCCN guidelines. *J Natl Comprehensive Cancer Network.* (2013) 11:531–46. doi: 10.6004/jnccn.2013.0070

9. Isobe Y, Nashimoto A, Akazawa K, Oda I, Hayashi K, Miyashiro I, et al. Gastric cancer treatment in Japan: 2008 annual report of the JGCA nationwide registry. *Gastric Cancer.* (2011) 14:301–16. doi: 10.1007/s10120-011-0085-6

10. Dan YY, So JB, Yeoh KG. Endoscopic screening for gastric cancer. *Clin Gastroenterol Hepatol.* (2006) 4:709–16. doi: 10.1016/j.cgh.2006.03.025

11. Kim Y, Jun JK, Choi KS, Lee HY, Park EC. Overview of the National Cancer screening programme and the cancer screening status in Korea. *Asian Pac J Cancer Prev.* (2011) 12:725–30.

12. Matsumoto S, Yamasaki K, Tsuji K, Shirahama S. Results of mass endoscopic examination for gastric cancer in Kamigoto Hospital, Nagasaki Prefecture. *World J Gastroenterol.* (2007) 13:4316–20. doi: 10.3748/wjg.v13.i32.4316

13. Allemani C, Weir HK, Carreira H, Harewood R, Spika D, Wang XS, et al. Global surveillance of cancer survival 1995-2009: analysis of individual data for 25,676,887 patients from 279 population-based registries in 67 countries (CONCORD-2). *Lancet.* (2015) 385:977–1010. doi: 10.1016/S0140-6736(14)62038-9

14. Zong L, Abe M, Seto Y, Ji J. The challenge of screening for early gastric cancer in China. *Lancet.* (2016) 388:2606. doi: 10.1016/S0140-6736(16)32226-7

15. Lee HY, Park EC, Jun JK, Hahm MI, Jung KW, Kim Y, et al. Trends in socioeconomic disparities in organized and opportunistic gastric cancer screening in Korea (2005-2009). *Cancer Epidemiol Biomarkers Prev.* (2010) 19:1919–26. doi: 10.1158/1055-9965.EPI-09-1308

16. Suh M, Song S, Cho HN, Park B, Jun JK, Choi E, et al. Trends in participation rates for the national cancer screening program in Korea, 2002-2012. *Cancer Res Treat.* (2017) 49:798–806. doi: 10.4143/crt.2016.186

17. Choi KS, Jun JK, Lee HY, Park S, Jung KW, Han MA, et al. Performance of gastric cancer screening by endoscopy testing through the National Cancer Screening Program of Korea. *Cancer Sci.* (2011) 102:1559–64. doi: 10.1111/j.1349-7006.2011.01982.x

18. Shen L, Zhou C, Liu L, Zhang L, Lu D, Cai J, et al. Application of oral contrast trans-abdominal ultrasonography for initial screening of gastric cancer in rural areas of China. *Dig Liver Dis.* (2017) 49:918–23. doi: 10.1016/j.dld.2017.04.008

19. Kim BJ, Heo C, Kim BK, Kim JY, Kim JG. Effectiveness of gastric cancer screening programs in South Korea: organized vs opportunistic models. *World J Gastroenterol.* (2013) 19:736–41. doi: 10.3748/wjg.v19.i5.736

20. Chen R, Liu Y, Song G, Li B, Zhao D, Hua Z, et al. Effectiveness of one-time endoscopic screening programme in prevention of upper gastrointestinal cancer in China: a multicentre population-based cohort study. *Gut.* (2021) 70:251–60. doi: 10.1136/gutjnl-2019-320200

21. Liu Q, Zeng X, Wang W, Huang RL, Huang YJ, Liu S, et al. Awareness of risk factors and warning symptoms and attitude towards gastric cancer screening among the general public in China: a cross-sectional study. *BMJ Open.* (2019) 9:e029638. doi: 10.1136/bmjopen-2019-029638

22. Crew KD, Neugut AI. Epidemiology of gastric cancer. *World J Gastroenterol.* (2006) 12:354–62. doi: 10.3748/wjg.v12.i3.354

23. Fock KM, Talley N, Moayyedi P, Hunt R, Azuma T, Sugano K, et al. Asia-Pacific consensus guidelines on gastric cancer prevention. *J Gastroenterol Hepatol.* (2008) 23:351–65. doi: 10.1111/j.1440-1746.2008.05314.x

24. Hahm MI, Choi KS, Park EC, Kwak MS, Lee HY, Hwang SS. Personal background and cognitive factors as predictors of the intention to be screened for stomach cancer. *Cancer Epidemiol Biomarkers Prev.* (2008) 17:2473–9. doi: 10.1158/1055-9965.EPI-08-0027

25. Hay JL, Orom H, Kiviniemi MT, Waters EA. "I don't know" my cancer risk: exploring deficits in cancer knowledge and information-seeking skills to explain an often-overlooked participant response. *Med Decis Making.* (2015) 35:436–45. doi: 10.1177/0272989X15572827

26. McCaffery K, Wardle J, Waller J. Knowledge, attitudes, and behavioral intentions in relation to the early detection of colorectal cancer in the United Kingdom. *Prev Med.* (2003) 36:525–35. doi: 10.1016/S0091-7435(03)00016-1

27. Quaife SL, Forbes LJ, Ramirez AJ, Brain KE, Donnelly C, Simon AE, et al. Recognition of cancer warning signs and anticipated delay in help-seeking in a population sample of adults in the UK. *Br J Cancer.* (2014) 110:12–8. doi: 10.1038/bjc.2013.684

28. Bai Y, Li ZS, Zou DW, Wu RP, Yao YZ, Jin ZD, et al. Alarm features and age for predicting upper gastrointestinal malignancy in Chinese patients with dyspepsia with high background prevalence of Helicobacter pylori infection and upper gastrointestinal malignancy: an endoscopic database review of 102,665 patients from 1996 to 2006. *Gut.* (2010) 59:722–8. doi: 10.1136/gut.2009.192401

29. Shin JY, Lee DH. Factors associated with the use of gastric cancer screening services in Korea: the Fourth Korea National Health and Nutrition Examination Survey 2008 (KNHANES IV). *Asian Pac J Cancer Prev.* (2012) 13:3773–9. doi: 10.7314/APJCP.2012.13.8.3773

30. Xiongwei Z. *Fujian Cancer Registry Annual Report.* Fujian Science and Technology Press (2018).

31. Li D, Wu C, Cai Y, Liu B. Association of NFKB1 and NFKBIA gene polymorphisms with susceptibility of gastric cancer. *Tumour Biol.* (2017) 39:1010428317717107. doi: 10.1177/1010428317717107

32. *Fujian Provincial Bureau of Statistics. Fujian Province Bulletin of the 7th National Census (No.2).* (2021). Available online at: https://tjj.fujian.gov.cn/xxgk/tjgb/202105/t20210520_5598804.htm (accessed July 3, 2022).

33. Becker MH. The health belief model and personal health behavior. *Health Edu Mono.* (1974) 2:324–508. doi: 10.1177/109019817400200407

34. Hosmer Jr DW, Lemeshow S, Sturdivant RX. *Applied Logistic Regression.* John Wiley & Sons (2013).

35. Hatamian S, Etesam S, Mazidimoradi A, Momenimovahed Z, Salehiniya H. The barriers and facilitators of gastric cancer screening: a systematic review. *J Gastrointest Cancer.* (2021) 52:839–45. doi: 10.1007/s12029-021-00652-8

36. China nationwide three-year cancer prevention plan (2015-2017). *Chin J Clin Oncol Rehabilit.* (2016) 23:177.

37. Aerdak N, Zhou J. An analysis of relevant cancer knowledge cognition and its factors among high risk group of upper gastrointestinal cancer in some parts of Urumqi. *China Cancer.* (2017) 26:268–71.

38. Jung M, Kim H, Yoon HY, Kim CB. Pre- and post-gastrectomy anemia in gastric cancer patients. *Korean J Clin Oncol.* (2011) 7:88–95. doi: 10.14216/kjco.11024

39. Di L, Wu H, Zhu R, Li Y, Wu X, Xie R, et al. Multi-disciplinary team for early gastric cancer diagnosis improves the detection rate of early gastric cancer. *BMC Gastroenterol.* (2017) 17:147. doi: 10.1186/s12876-017-0711-9

40. Sugano K. Screening of gastric cancer in Asia. *Best Pract Res Clin Gastroenterol.* (2015) 29:895–905. doi: 10.1016/j.bpg.2015.09.013

41. Lee EY, Lee YY, Suh M, Choi E, Mai TTX, Cho H, et al. Socioeconomic inequalities in stomach cancer screening in Korea, 2005-2015: after the introduction of the national cancer screening program. *Yonsei Med J.* (2018) 59:923–9. doi: 10.3349/ymj.2018.59.8.923

42. Uemura N, Okamoto S, Yamamoto S, Matsumura N, Yamaguchi S, Yamakido M, et al. Helicobacter pylori infection and the development of gastric cancer. *N Engl J Med.* (2001) 345:784–9. doi: 10.1056/NEJMoa001999

Let There Be Light—Digital Eye Strain (DES) in Children as a Shadow Pandemic in the Era of COVID-19: A Mini Review

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Introduction: Digital eye strain, which is often ignored by the public, has emerged as a "Shadow Pandemic" in the era of the COVID-19 pandemic.

Aim: The current paper is aimed at discussing the ill effect of digital screens on eyes in the wake of the COVID-19 pandemic.

Methodology: A literature search was done using "PubMed," "Google scholar", and "Scopus" using key terms like "Digital Eye Strain," "Eyestrain," or "Computer Vision Syndrome." Relevant articles were identified and included to support the argument for this narrative review.

Results: Studies conducted in the UK reported that 68% of children extensively use computers, while 54% undertake online activities after the age of 3. Similar studies estimated 4 h and 45 min per day of screen exposure time among adults in the UK. Indian studies reveal that the prevalence of DES is 69% in adults and 50% in children respectively. Indian ophthalmologists found that computer-using and specialized ophthalmologists were more informed of symptoms and diagnostic signs but were misinformed about treatment modalities. The use of social media and multitasking is particularly prominent among younger adults, with 87% of individuals aged 20–29 years reporting the use of two or more digital devices simultaneously. It has been observed that the use of computer glasses corrects refractive errors and helps in the reduction of symptoms, while precision spectral filters help in reducing symptoms of micro-fluctuation of accommodation.

Conclusion: We concluded that DES is emerging globally as a "Shadow Pandemic" and it is high time to respond. Community ophthalmologists, public health authorities, and educational sectors especially should be involved to prevent this.

Keywords: computer vision syndrome, digital eye strain, digital eye syndrome, COVID-19, public health, pandemic

INTRODUCTION

The nationwide lockdown was extended and completed Phase 4 on May 31, 2020, to effectively limit the COVID-19 pandemic and flatten the curve in India as well as many other countries throughout the world. Throughout this lockdown, it was discovered that pupils' education was deteriorating, and it was necessary to consider how the specified curriculum might be fulfilled. The University Grants Commission (UGC) in India established two committees to oversee examinations and the academic calendar, as well as to encourage online learning. In addition, the UGC chairman advocated social distance, web-based learning, and e-education to prevent the spread of the ongoing COVID-19 pandemic.

With the outbreak of the COVID-19 pandemic, not only current University students, but also pupils from primary and secondary schools, were encouraged to participate in e-learning to complete the required curriculum on time. The recommendations published by the appropriate authorities were insufficient to instruct instructors and students on how and when to use e-learning methods. Without any limitations, our children are increasingly spending most of their time (almost 8 h each day) in front of computer or smart phone displays. E-learning approaches can have both positive and negative effects on our children's vision. In addition, students used online platforms for entertainment, communication, and information purposes during this pandemic. Due to the surge in COVID-19 cases, adults were encouraged to continue their work from home, and they were exposed to screens for a long duration. As result of home confinement, they used online platforms for entertainment, communication, and information.

Computer displays and smart phone screens generate blue light with wavelengths ranging from 380 to 500 nm, which can be hazardous to health. These high-energy waves can reach the eyes, causing everything from irritation to retinal damage. Dry eyes, impaired vision, headaches, near-sightedness, and eye fatigue are among the symptoms that can be induced by the dazzling effect of blue light. Digital eye strain (DES) or computer vision syndrome is the collective term for this (1).

A "collection of eye and vision-related issues that occur from extended computer, tablet, e-reader, and mobile phone usage," according to DES, is an increasing public health hazard. When using digital screens for long periods of time, people may have minor to severe eye irritation and vision problems. The most prevalent symptoms of DES, according to the American Optometric Association, are eyestrain, headaches, impaired vision, dry eyes, and neck and shoulder pain (1).

The amount of time spent looking at a digital screen is directly related to eye pain. Many millions of people of all ages are at risk of DES due to the tremendous surge in digital gadget usage in recent years. While the symptoms are typically temporary, the illness can cause severe and regular pain for sufferers, as well as having major financial implications. Long-term exposure to blue light emitted by electronic gadgets, according to experts, can have serious consequences. Long-term exposure can cause photochemical damage to the eyes, which can lead to retinal cell destruction and make a person prone to age-related macular degeneration. Children are the most vulnerable age group.

With this goal in mind, we've put together this paper to talk about how long-term e-learning causes DES, how to correct accountability issues, and how to solve the problem.

METHODOLOGY

In the aftermath of COVID-19, the current study attempted to address the impact of digital displays on the eyes. The key phrases DES, Eye strain, and computer vision syndrome were searched for in the "PubMed," "Google Scholar," and "Scopus" databases. To complement the narrative review, all relevant articles were included in this publication.

RESULTS

Children typically have uncorrected vision difficulties such as farsightedness and astigmatism, insufficient eye focusing, or eye coordination abilities, all of which can lead to the development of visual symptoms when using a computer or digital screen device for a longer length of time. By the age of three, 68% of youngsters in England use computers on a regular basis, and 54% engage in online activities (2). Furthermore, other research found that adults in the United Kingdom spend between 4 and 45 min per day on screens (3), whereas adults in the United States spend almost two-thirds of their time on digital devices (5 h or more) (4).

According to recent US data, 37% of people aged 60 and overspend five or more hours per day on digital devices, and this age group likes to browse the internet on laptops and desktop computers, whereas younger folks prefer to do it on smartphones (4). Younger people are more likely to use social media and multitask, with 87 percent of those aged 20–29 indicating that they use two or more digital devices at the same time (4). The 2016 Digital Eye Strain research, which included answers from over 10,000 people in the US, found a 65 percent frequency of self-reported symptoms, with females being more impacted than males (69 vs. 60% prevalence) (4). Participants who used two or more devices at the same time were more likely to report DES than those who only used one device at a time, with prevalence rates of 75 and 53%, respectively. Various symptoms of DES arise after using mobile phones for more than 2 h daily (5), or digital devices after 2–4 h of exposure (6).

Sheppard and Wolffsohn (7) found that 27.5% of people have irritated or burning eyes, 31.5% have dry eyes, 30.6% have eye strain, 22.3% have headaches, 39.8% have tired eyes, 26.3% have sensitivity to bright lights, and 30.8% have eye discomfort. Eye health is negatively affected by online education and eye fatigue increased as a result of the COVID-19 pandemic process (8). Research was done in India to examine the prevalence of DES among computer users in the state of Bihar. The frequency of DES was discovered to be 69 percent. Around 30 percent of people utilized the computer for 4–6 h every day. Eyestrain and weariness were the most prevalent complaint in 59 (59%)

people, followed by headache in 57 (57%) people, discomfort in the neck, shoulder, wrist, or back in 51 (51%) people, dry eyes in 37 (37%) people, and blurred vision in 35 (35%) people. CVS was mentioned by 11 people (11%). The most prevalent preventative intervention was taking pauses in between work, which was taken by 79 participants (79%). In the current study, 46 (46%) individuals took preventative breaks after 1 h and 25 (25%) after 20 min (9). According to research from Egypt, 86%of medical students who spent 3 h or more per day on the computer were suffering from one or more DES symptoms (10). Other symptoms were dry eyes, headache, blurred vision, eye strain, neck and shoulder pain, weariness, and eye redness. A study from Bulgaria shows similar results. Of those studied, 7.4% of students had ca onstant feeling and 25% often had feelings of eye soreness and irritation. Eye dryness, grittiness, and scratchiness was constantly experienced by 9.6% of the students and 19.1% felt it frequently (11). Study results from Israel and the USA reveal eye fatigue (60 and 48%), eye strain (58 and 31%), ocular discomfort (44 and 31%), headaches (43 and 26%), dry eyes (39 and 34%), and burning eyes (40 and 22%) (12). Computer-using and specialized ophthalmologists know more about symptoms and diagnostic signals than traditional ophthalmologists, yet they lack different treatment options (13). Recent results from Indian research found that the average age of children with DES was 13 ± 2.45 years. The average time spent on a digital device was 3.9 ± 1.9 h, up from 1.9 ± 1.1 h in the pre-COVID era ($P = 0.0001$). Smartphones were the most popular digital device among the participants ($n = 134$, or 61.7%). A total of 108 youngsters (49.8%) spent more than 2 h every day on online programs. The prevalence of DES was 50.23% in that group. There were 26.3% light cases, 12.9% moderate cases, and 11.1% severe cases. Itching and headache were the most often reported symptoms ($n = 117$, 53.9%). Age >14 years ($P = 0.04$), male gender ($P = 0.0004$), smartphone usage ($P = 0.003$), device use >5 h ($P = 0.0007$), and mobile games >1 h per day ($P = 0.0001$) were all found to be independent risk factors for DES in youngsters (14). Playing applications and games, as well as surfing the internet, are a common practice for our youngsters in the present digital world (8). Furthermore, most children lack the self-control necessary to set boundaries for themselves.

A study revealed that an 86% ($n = 584$) prevalence of DES was observed in those who had at least one symptom. As per the study, computer devices are used by participants mainly for learning and entertainment. One third of participants were continuously using digital screens for >2 h and one-fourth of participants were using the screen for >9 h; 20% used the screen in a dark room or dim light for >5 h. 66% had mild and 2.2% had severe symptoms. Headache was the common symptom found, followed by eye pain and neck/shoulder/joint pain. Females were found to be more prone to develop CVS. Headache, eye redness, burning, etc. were positively correlated with the duration of use (15). During the current pandemic, the creation of e-classes for such youngsters has placed an undue weight on their already strained eyes.

DES diagnosis and measurement: Both objective and subjective approaches have been used to assess DES. Objective evaluations of parameters such as critical flicker–fusion frequency blink rate and completeness, accommodative function, and pupil characteristics may be used to provide indices of visual fatigue. Subjective methods include a 10-item questionnaire produced by Hayes et al. (16) and utilized in various studies. It considers the symptoms of DES and scores each symptom separately. Another six-item Visual Fatigue Scale allows users to assess their difficulty in seeing, unusual feelings around the eyes, eyes feeling weary, feeling numb, having a headache, and feeling dizzy when gazing at the screen using a Likert scale (7). The Rasch-based Computer-Vision Symptom Scale is another tool that researchers may use to assess visual and ocular complaints in computer users. The self-administered Computer Vision Syndrome Questionnaire (CVS-Q) asks users to rate the frequency and severity of 16 symptoms they encounter when using a computer, resulting in a single symptom severity score (CVS score) of six or higher, which is considered diagnostic of the disease (17). The physiological underpinning of DES is used in objective evaluations. The exact process behind DES, however, remains unknown. In contemporary DES research, critical flicker–fusion frequency (CFF) and blinking characteristics have been utilized often to assess visual functions (7). Ergonomic practices, maintaining regular blinking, the use of adequate lighting, careful placement of the digital device, altering image characteristics (resolution, text size, contrast, and brightness), and taking breaks are all frequent non-pharmacological and pharmaceutical treatments. Artificial tears are one of the pharmacological management techniques.

According to Reddy et al. (18), only taking breaks from screens is insufficient for reducing DES symptoms, but concentrating on long-distance objects between breaks relates to a considerably better prognosis. The 20/20/20 method (looking at items over 20 feet away for 20 s after 20 min of visual display unit use) is very widespread advice in the literature (19). Furthermore, using antiglare displays in electronic devices to prevent eye strain is a common but less acknowledged ergonomic approach. The evidence for the antiglare screen's preventative advantages in DES is mixed. Ranasinghe et al. (17) and Shantakumari et al. (20) observed that individuals who used antiglare displays had fewer DES symptoms, but Reddy et al. (18) and Scullica et al. (21) reported that screen filters have no effect on DES symptoms. Some research has suggested that increasing ergonomic health literacy behaviors, as well as creating an ergonomic work environment, is a good way to avoid DES among screen users. It has been discovered that wearing computer glasses corrects refractive errors and reduces symptoms, whilst using precision spectrum filters reduces the symptoms of micro-fluctuation of accommodation. Anti-glare lenses are contentious, and there is no universal agreement on how to utilize them. Dry eye symptoms can be efficiently managed with artificial tears and omega-3 fatty acid consumption. On-screen prompts, audial prompts, or wink glass can all help users raise their effective blinking rate, which is known to be one of the most critical elements in preventing DES. In a qualitative European study of 368 children aged 9–16, subjects were queried on what they perceive as negative while using the internet and technology in general. To reduce the variety of eye problems,

such as eye strain and eye irritation, the usage of eye glasses following prolonged internet use may help (22). A novel therapy modality called *"Warming Device"* might be a good alternative to the present therapeutic techniques for computer vision disorders (23, 24).

CONCLUSION

A "Shadow Pandemic" is brewing because of DES. We are inadvertently driving a generation of youngsters toward a higher risk of DES due to the present trend of e-learning programs and its repercussions.

RECOMMENDATIONS

A wide range of evidence is available to assess for the prevalence of DES among adult screen users, although comparable data for youngsters is scarce. Given the current COVID-19 pandemic and the growing burden of screen exposure of more than 12 h per day among youngsters, it is vital for policymakers in the education and health sectors to provide guidelines (e.g., limiting e-learning time for students to reduce screen time). Similar guidelines should be framed for the adults who are working from home with digital devices for a

long time. Ophthalmologists can also be informed about the diagnosis and innovative therapy options for computer vision syndrome.

LIMITATIONS

There are a few restrictions to this evaluation. It is a narrative review in which the evidence is retrieved and synthesized without using a systematic technique. We used a negative review technique due to the scarcity of research in this field, which is still a problem. There are also other limitations to this review. It is narrative review, although it emphasizes one of the most important public health issues in the post-pandemic era globally, which will likely drive future strategies aimed at avoiding DES in this relatively young population. The findings should be reproduced, and they should be compared to nations in Europe that have been subjected to protracted lockdowns, such as Italy, Austria, and Germany. As a result, more research, including both primary studies and evidence synthesis, is needed to inform decisions and practice.

AUTHOR CONTRIBUTIONS

All authors contributed equally.

REFERENCES

1. Madhan MRR. Computer vision syndrome. *Nurs J India.* (2009) 100:236–7.
2. Palaiologou I. Children under five and digital technologies: implications for early years pedagogy. *Eur Early Childh Educ Res J.* (2016) 24:5–24. doi: 10.1080/1350293X.2014.929876
3. eMarketer. *Mobile Takes Majority Share of UK Time With Digital Media.* (2016). Available online at: https://www.emarketer.com/Article/Mobile-Takes-Majority-Share-of-UK-Time-with-Digital-Media/ 1014676 (accessed May 29, 2020).
4. The Vision Council. *Eyes Overexposed: The Digital Device Dilemma: Digital Eye Strain Report.* (2016). Available online at: https://www.thevisioncouncil.org/content/digital-eye-strain (accessed May 29, 2020).
5. Moon, JH, Kim, KW, Moon, NJ. Smartphone use is a risk factor for pediatric dry eye disease according to region and age: a case control study. *BMC Ophthalmol.* (2016) 16: 188. doi: 10.1186/s12886-016-0364-4
6. Kim J, Hwang Y, Kang S, Kim M, Kim T-S, et al. Association between exposure to smartphones and ocular health in adolescents. *Ophthalmic Epidemiol.* (2016) 23:269–76. doi: 10.3109/09286586.2015.1136652
7. Sheppard AL, Wolffsohn JS. Digital eye strain: prevalence, measurement and amelioration. *BMJ Open Ophthalmol.* (2018) 3:e000146. doi: 10.1136/bmjophth-2018-000146
8. Huseyin KAYA. Investigation of the effect of online education on eye health in COVID-19 pandemic. *Int J Assess Tools Educ.* (2020) 7:488–96. doi: 10.21449/ijate.788078
9. Kumar N, Sharma N. To determine the prevalence of computer vision syndrome among computer users: a descriptive study. *Eur J Mol Clin Med.* (2020) 7:3933–38. Available online at: https://ejmcm.com/article_10411.html
10. Iqbal M, El-Massry A, Elagouz M, Elzembely H. Computer vision syndrome survey among the medical students in Sohag University Hospital, Egypt. *Ophthalmol Res.* (2018) 8:1–8. doi: 10.9734/OR/2018/38436
11. Ivancheva V, Valcheva K, Lyubenov A. COVID pandemic: eye comfort and remote education. *Наука и практ.* (2018) 333.
12. Gantz L, Rosenfield M. Digital eye strain symptoms during online University learning in Israel and the USA during the COVID-19 pandemic. *Invest*

13. *Ophthalmol Vis Sci.* (2021) 62:1975. Available online at: https://iovs.arvojournals.org/article.aspx?articleid=2774975
13. Bali J, Navin N, Thakur BR. Computer vision syndrome: a study of the knowledge, attitudes and practices in Indian ophthalmologists. *Indian J Ophthalmol.* (2007) 55:289–94. doi: 10.4103/0301-4738.33042
14. Mohan A, Sen P, Shah C, Jain E, Jain S. Prevalence, and risk factor assessment of digital eye strain among children using online e-learning during the COVID-19 pandemic: digital eye strain among kids (DESK study-1). *Indian J Ophthalmol.* (2021) 69:140–4. doi: 10.4103/ijo.IJO_2535_20
15. Babu JV, Abraham S, Biju MJ, Jose J, Impact of digitalization in the eye strain during COVID - 19 lockdown period: an epidemiological study. *J Drug Del Therap.* (2021) 11:7–14. doi: 10.22270/jddt.v11i1-s.4672
16. Hayes SC, Strosahl KD, Wilson KG, Bissett RT, Pistorello J, Toarmino D, et al. Measuring experiential avoidance: a preliminary test of a working model. Psychol Rec. (2004) 54:553–78. doi: 10.1007/BF03395492
17. Ranasinghe P, Wathurapatha WS, Perera YS, Lamabadusuriya DA, Kulatunga S, Jayawardana N, et al. Computer vision syndrome among computer office workers in a developing country: an evaluation of prevalence and risk factors. *BMC Res Notes.* (2016) 9:150. doi: 10.1186/s13104-016-1962-1
18. Reddy SC, Low CK, Lim YP, Low LL, Mardina F, Nursaleha MP. Computer vision syndrome: a study of knowledge and practices in University students. *Nepal J Ophthalmol.* (2013) 5:161–8. doi: 10.3126/nepjoph.v5i2.8707
19. Coles-Brennan C, Sulley A, Young G. Management of digital eye strain. *Clin Exp Optom.* (2019) 102:18–29. doi: 10.1111/cxo.12798
20. Shantakumari N, Eldeeb R, Sreedharan J, Gopal K. Computer use and vision-related problems among University students in Ajman, United Arab Emirate. *Ann Med Health Sci Res.* (2014) 4:258–63. doi: 10.4103/2141-9248.129058
21. Scullica L, Rechichi C, De Moja CA. Protective filters in the prevention of asthenopia at a video display terminal. *Percept Mot Skills.* (1995) 80:299–303. doi: 10.2466/pms.1995.80.1.299
22. Smahel, D, Wright, MF, Cernikova, M. The impact of digital media on health: children's Perspectives. *Int J Public Health.* (2015) 60:131–7. doi: 10.1007/s00038-015-0649-z
23. Ilango K. Warming device for computer vision syndrome. *Indian J Ophthalmol.* (2008) 56:171. doi: 10.4103/0301-4738.39139

24. Takahashi Y, Igaki M, Suzuki A, Takahashi G, Dogru M, Tsubota K. The effect of periocular warming on accommodation. *Ophthalmology*. (2005) 112:1113–8. doi: 10.1016/j.ophtha.2004.12.040

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Adapted digital health literacy and health information seeking behavior among lower income groups in Malaysia during the COVID-19 pandemic

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Background: Misinformation has had a negative impact upon the global COVID-19 vaccination program. High-income and middle-income earners typically have better access to technology and health facilities than those in lower-income groups. This creates a rich-poor divide in Digital Health Literacy (DHL), where low-income earners have low DHL resulting in higher COVID-19 vaccine hesitancy. Therefore, this cross-sectional study was undertaken to assess the impact of health information seeking behavior on digital health literacy related to COVID-19 among low-income earners in Selangor, Malaysia.

Methods: A quantitative cross-sectional study was conducted conveniently among 381 individuals from the low-income group in Selangor, Malaysia. The remote data collection (RDC) method was used to gather data. Validated interviewer-rated questionnaires were used to collect data *via* phone call. Respondents included in the study were 18 years and older. A normality of numerical variables were assessed using Shapiro-Wilk test. Univariate analysis of all variables was performed, and results were presented as means, mean ranks, frequencies, and percentages. Mann-Whitney U test or Kruskal Wallis H test was applied for the comparison of DHL and health information seeking behavior with characteristics of the participants. Multivariate linear regression models were applied using DHL as dependent variable and health information seeking behavior as independent factors, adjusting for age, gender, marital status, educational status, employment status, and household income.

Results: The mean age of the study participants was 38.16 ± 14.40 years ranging from 18 to 84 years. The vast majority (94.6%) of participants stated that information seeking regarding COVID-19 was easy or very easy. Around 7 percent of the respondents cited reading information about COVID-19 on the internet as very difficult. The higher mean rank of DHL search, content, reliability, relevance, and privacy was found among participants who were widowed, had primary education, or unemployed. An inverse relationship was found between overall DHL and confidence in the accuracy of the information on the internet regarding COVID-19 ($\beta = -2.01$, 95% CI $= -2.22$ to -1.79).

Conclusion: It is important to provide support to lower-income demographics to assist access to high-quality health information, including less educated, unemployed, and widowed populations. This can improve overall DHL.

Introduction

The World Health Organization (WHO) defines Digital Health Literacy as the ability to utilize electronic devices to gain, seek, appraise, and understand health information to enhance health outcomes or solve a health issue (1). Recent advancement in technology has made the world more digitalized than before, and thus most populations have access to information about healthcare.

Access to timely and quality information during infectious diseases outbreak is critical to prevent the spread of infection and control the feelings of anxiety. Digital platforms are the main focal points where information exists and spreads (2). Quality and up-to-date information from such platforms about the source of the pandemic, specific health threats, dissemination, mortality, can minimize the risk of infection and public anxiety. However, access to online quality information has been a challenge for vulnerable population such as migrants and the older group. There is a disparity that exists in digital health equity which needs to be highlighted (3, 4).

Social media platforms (Facebook, Twitter, Instagram, etc.) has become a perfect source for health information to flow. There are significant quantities of good and bad public health messaging on social media platforms, which can impact individual and population beliefs and behaviors. In light of the ongoing pandemic, misinformation about the source of the pandemic had become increasingly available on different social media platforms (5). Hence, the pandemic highlighted the negative impacts of false misinformation on all facets of life (6). Misinformation about the source of the Coronavirus disseminated rapidly all across the world that even the WHO coined another word "infodemic," an overabundance of information and the rapid spread of misleading or fabricated news, images, and videos (7).

Vaccine hesitancy which is one of main global health issues has also taken a surge because of the bulk of misinformation available on social media platforms (8). In studies published, it has shown that the population's decision to vaccinate was influenced by the information on digital platforms (9, 10). Concerns about side effects of the vaccines, rapid development of the vaccines have all contributed to vaccine hesitancy (11, 12). On the other hand, in some countries, the digital platforms have increased public trust on vaccines (13). Thus, it is critical to monitor the digital platforms and make good use of them to help people in their decision making.

Studies have unanimously agreed that COVID-19 has severe health repercussions, including quality of life (14), mental health (15–19), and psychological distress (20–25). Misinformation and vaccine efficacy also impacted the global COVID-19 vaccination program, driving vaccine hesitancy (26–28). However, recommendations from medical professionals' were associated with vaccine acceptance (29, 30). Safety is one of the key population concerns, and in many countries, misinformation has led people to believe that vaccines are not safe, thus increasing hesitancy (31). It is one of the many reasons why the pandemic has not ended.

Malaysia, a Southeast Asian country, has had its own struggles with the pandemic. As of July 14 2022, 4.6 million cases and 35.8 thousand deaths have been reported (32). The country began COVID-19 vaccination in February 2021, and as of 14 July 2022, Malaysia has administered at least 71.5 million doses of COVID vaccines so far, assuming every person needs two doses (33).

Malaysia's population is divided into three categories based on their household income. T20 is also known as the Upper

group, which represents the top 20% of the Malaysians; M40, also known as Middle-income, which represent 40% of the Malaysians; and B40%, also known as the Lower-income group, which represents 40% of the Malaysians (34).

High-income and middle-income earners typically have better access to technology and health facilities than the B40 lower-income group (35). Lower-income groups may also have less access to healthcare; there is previous evidence of greater vaccine hesitancy within these demographics (29, 36). Therefore, it is increasingly important to review the engagement of lower income groups in misinformation and identify how best to provide educational support for them using social media and other digital platforms. In addition, it is proven that digital health literacy contributes to better health outcomes (37). This cross-sectional study was undertaken to assess the impact of health information seeking behavior on digital health literacy related to COVID-19 among low-income earners, also known as "B40," to provide an update for health policymakers on the use of digital health among B40 group and contribute to the improving of their health condition.

Methods

Study setting and population

This cross-sectional study was conducted *via* telephone and according to the protocol approved by the Ethics Committee of Management and Science University (Ethics Code: MSU-RMC-02/FR01/09/L1/085). A quantitative cross-sectional study was conducted conveniently among 381 individuals from the low-income group in Selangor, Malaysia. People from lower socioeconomic classes are vulnerable populations negatively affected by the COVID-19 pandemic, thus exacerbating disparities in digital health literacy. According to the Raosoft online sample size calculator (Raosoft, Seattle, WA, US), assuming a 5% margin of error, a 95% confidence level, and a 50% response distribution, the required sample size for this study was 377.

The survey was conducted between 20 September to 3 October 2021 (during the MCO 3.0). The questionnaire was piloted on a sample of 30 to test its validity and reliability, and data obtained from the pilot study were not included in the final analysis. A total of 381/452 (84.3%) participants completed the survey. The remote data collection (RDC) method was used to gather data. Validated interviewer-rated questionnaires were used to collect data *via* phone call. Respondents included in the study were 18 years and older, belonged to the low-income group (B40), living in Selangor. Only one response was allowed per contact number in the telephone survey. We got the list of names and mobile numbers from our university, who adopted the said community.

Study instruments

This study used a questionnaire that was available in both Bahasa Melayu and English languages. Before questionnaire distribution, a back-to-back translation, content and face validity, and reliability test were done. The questionnaire consisted of 13 items and was divided into three sections. The following data were collected upon the completion of each questionnaire: Section A – sociodemographic profile (6 items), Section B – digital health literacy (5 items from the Digital Health Literacy Instrument (DHLI), adapted from Vaart and Drossaerts, 2017 (37), Section C – health information seeking behavior (2 items, self-developed). The online survey has fulfilled the criteria in the Checklist for Reporting Results of Internet E Surveys (CHERRIES) (2).

Sociodemographic profile

The sociodemographic characteristics collected for this study were age, gender, marital status, education level, household income and employment status.

Digital health literacy

The questions used to assess digital health literacy were adapted from the Development of the Digital Health Literacy Instrument (37). This study adopted five items – one item from every five key dimensions of DHLI, namely, information seeking, adding self-generated content, evaluating reliability, determining relevance, and protecting privacy. The scale measures one's ability to seek, find, understand, and appraise health information from digital resources. This study used the following five key dimensions of DHLI, namely, (1) information searching or using appropriate strategies to look for information (e.g., "When you browse the internet to find information regarding the Coronavirus or related topics, how easy or difficult is it for you to find the exact information?") (2) adding self-generated content to online-based platforms (e.g., "When typing a message (e.g., on a forum or social media such as Facebook or Twitter) about the coronavirus a related topic. How easy or difficult is it for you to express your opinion, thought, or feelings in writing??") (3) evaluating the reliability of online information (e.g., "When you search the internet for information on the coronavirus or related topics, how easy or difficult is it for you to decide whether the information is reliable or not?") (4) determining the relevance of online information (e.g., "When you search the internet for information on the coronavirus or related topics, how easy or difficult is it for you to use the information you found to make decisions about your health (protective measures, hygiene regulations, transmission routes, risks and their prevention?") and (5) protecting privacy (e.g., "When you post a message about the coronavirus or related

topics on a public forum or social media, how often do you share your own private information such as your name or address?") A total of 5items were asked and it uses a four-point Likert scale: 1 = very difficult, 2 = difficult, or some of the time, 3 = easy, and 4 = very easy.

Health information-seeking behavior

This section consisted of 2 self-developed questions to assess health information-seeking behavior. Each item was scored on a 5-point Likert scale. The first question is *"How often do you read information about COVID-19 on the internet"* for which the response options are 5 (at least once a day), 4 (at least once a week), 3 (at least once a month), 2 (less than once a day), and 1 (never). The second question is *"I am confident in the accuracy of the information that I see and read in social media,"* with response options ranging from 5 (strongly agree), 4 (agree), 3 (neutral), 2 (disagree), and 1 (strongly disagree).

Validity and reliability

A group of expert panels were included such as psychiatrists, clinical psychologists, physicians, pharmacists, and public health experts translated and culturally validated the questionnaire. The set of questions included for Content Validation Index (CVI) calculation was five questions in Section B (digital health literacy) and two questions in Section C (health information

seeking behavior). All the questions received an acceptable CVI of more than 70%. The final CVI for both questionnaires calculated was from 88.5 to 97.5%. Other psychometric properties such as face validity and reliability were assessed by conducting a pilot study of 30 subjects. The final face validity index for both questionnaires ranged from 92.5 to 94.7%, and the internal consistency for all the sections was good, with Cronbach's alpha values ranging from 0.87 and 0.94.

Data analysis

Data were analyzed using Statistical Package for Social Sciences (SPSS) statistical software version 25.0. The normality of numerical variables were assessed using the Shapiro-Wilk test. Univariate analysis of all variables was performed, and results were presented as means, SDs, mean ranks, frequencies, and percentages. Mann-Whitney U test or Kruskal Wallis H test was applied to compare DHL and health information-seeking behavior with the characteristics of the participants. Linear regression was applied by taking overall DHL as the dependent variable and health information-seeking behavior as independent factors. A multivariate linear regression model was derived for overall DHL and health information-seeking behavior after adjusting for age, gender, marital status, educational status, employment status, and household income. A p-value of < 0.05 was considered as statistically significant.

TABLE 1 Digital health literacy and health information seeking behavior of participants ($n = 301$).

Level of DHL (digital health literacy)	Very easy	Easy	Difficult	Very difficult
Information searching/seeking	119 (39.5)	166 (55.1)	15 (5)	1 (0.3)
Adding self-generated content	68 (22.6)	137 (45.5)	80 (26.6)	16 (5.3)
Evaluating reliability	69 (22.9)	148 (49.2)	74 (24.6)	10 (3.3)
Determining relevance	69 (22.9)	174 (57.8)	49 (16.3)	9 (3)
Protecting privacy	60 (19.9)	106 (35.2)	102 (33.9)	33 (11)

Health information-seeking behavior	Never	At least once a day	At least once a week	At least once a month
How often do you read information about COVID-19 on the internet?	4 (1.3)	166 (55.1)	110 (36.5)	21 (7)

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
I am confident with the accuracy of the information I read about COVID-19 on social media.	4 (1.3)	41 (13.6)	102 (33.9)	116 (38.5)	38 (12.6)

Data presented as n (%).

Results

The mean age of the study participants was 38.16 ± 14.40 years ranging from 18 to 84 years, and most participants were of age < 40 years (53.8%). Of 381 participants, 59.3% were females, and 40.7% were males. Most participants were married (55.4%), followed by singles (35.4%). Almost 39.4% of the participants had secondary level education, 56.2% were employed, and 59.3% had household income < RM2,500 per month (B1, ∼$560 US dollars).

Table 1 depicts the proportion of respondents who reported digital health literacy and health information-seeking behavior during COVID-19. Almost two-fifths (39.5%) of respondents stated that the information searching/seeking regarding COVID-19 was very easy, and more than half (55.1%) stated that it was easy. Only 5% of the respondents could find information searching/seeking difficult or very difficult. Almost one-fourth of the respondents stated that it was difficult to add self-generating content (26.6%) and to evaluate the reliability (24.6%) of the COVID-19-related digital health literacy.

TABLE 2 Comparison of participants' characteristics and digital health literacy ($n = 301$).

Characteristics	Overall DHL	DHL search	DHL contents	DHL reliability	DHL relevance	DHL privacy
Age groups						
<40 years	168.82	171.16	170.98	166.86	163.68	162.79
40–60 years	210.39	208.14	208.45	211.86	215.99	215.76
>60 years	261.95	255.86	255.41	269.91	270.68	280.57
p-value	0.001*	0.001*	0.001*	0.001*	0.001*	0.001*
Gender						
Male	195.07	193.60	192.54	200.54	200.93	195.65
Female	188.21	189.21	189.95	184.46	184.19	187.81
p-value	0.55	0.68	0.82	0.14	0.12	0.48
Marital status						
Single	180.20	179.23	179.56	172.61	171.51	169.47
Married	192.37	193.82	191.90	198.51	197.60	198.28
Divorced	170.57	174.79	173.86	183.93	192.29	198.07
Widowed	263.18	258.62	262.09	252.94	248.26	282.18
Single parent	198.64	187.09	215.18	181.45	214.27	170.14
p-value	0.06	0.05	0.04*	0.03*	0.02*	0.001*
Educational level						
Primary	242.76	238.45	233.94	251.28	251.55	256.01
Secondary	200.64	201.45	203.84	203.75	204.43	207.29
Post-secondary education (pre-university/Diploma)	175.42	167.21	181.87	170.20	168.44	170.28
Tertiary education (Degree/Master)	168.57	183.88	155.11	166.30	167.78	155.78
p-value	0.001*	0.001*	0.001*	0.001*	0.001*	0.001*
Employment status						
Employed	178.43	181.53	177.40	178.32	183.19	182.71
Not employed	226.03	223.74	226.32	229.40	219.92	224.28
Student	180.89	174.59	183.62	176.56	174.79	170.23
p-value	0.001*	0.001*	0.001*	0.001*	0.01*	0.001*
Household income per month (Malaysian ringgit)						
< RM2,500 (B1)	197.99	196.22	208.52	193.93	196.53	197.77
RM2,501 – RM3,169 (B2)	176.02	176.40	168.62	179.93	175.15	184.59
RM3,170 – RM3,969 (B3)	180.76	187.44	169.63	200.96	190.34	174.85
RM3,970 – RM4,849 (B4)	192.17	196.07	154.06	189.35	194.35	178.90
p-value	0.42	0.49	0.001*	0.70	0.45	0.49

Data presented as mean rank.
Mann-Whitney U test/Kruskal Walis test was applied.
*Significant at 0.05 level of significance.

TABLE 3 *Post-hoc* analysis in Kruskal Walis test.

	Overall DHL	DHL search	DHL contents	DHL reliability	DHL relevance	DHL privacy
Age groups						
<40 years-40–60 years	0.001*	0.002*	0.003*	0.001*	0.001*	0.001*
40–60 years->60 years	0.114	0.127	0.157	0.048*	0.062	0.024*
<40 years->60 years	0.001*	0.001*	0.001	0.001*	0.001*	0.001*
Marital status						
Married-divorced			0.999	0.999	0.999	0.999
Married-single			0.999	0.26	0.225	0.146
Married-single parent			0.999	0.999	0.999	0.999
Married-widow			0.087	0.408	0.527	0.019*
Divorced-single			0.999	0.999	0.999	0.999
Divorced-single parent			0.999	0.999	0.999	0.999
Divorced-widow			0.642	0.999	0.999	0.803
Single-single parent			0.999	0.999	0.999	0.999
Single-widow			0.025*	0.031*	0.040*	0.001*
Single parent-widow			0.999	0.999	0.999	0.069
Educational status						
Tertiary education-post secondary education	0.999	0.999	0.563	0.999	0.999	0.999
Tertiary education-sSecondary education	0.259	0.999	0.010*	0.088	0.091	0.006*
Tertiary education-primary education	0.004*	0.050*	0.001*	0.001*	0.001*	0.001*
Post-secondary education-secondary education	0.343	0.038*	0.533	0.054	0.026*	0.027*
Post-secondary education-primary education	0.005*	0.001*	0.046*	0.001*	0.001*	0.001*
Secondary education-primary education	0.19	0.276	0.688	0.073	0.069	0.068
Income groups						
B4-B2			0.999			
B4-B3			0.999			
B4-B1			0.026*			
B2-B3			0.999			
B2-B1			0.019*			
B3-B1			0.276			

*$P < 0.05$.

Another one-third (33.9%) find it difficult to protect privacy. More than half of the respondents (55.1%) read information about COVID-19 at least once in a day, and one-third (36.5%) received so at least once a week.

Table 2 compares respondents' characteristics and the overall DHL and its five components by the Mann-Whitney U test or Kruskal Wallis test. Overall, a higher DHL mean rank was found among the participants age > 60 years (mean rank = 261), who had primary education (mean rank = 242.76) and who were not employed (mean rank = 226.03). A statistically significant difference in overall DHL was observed for educational level ($p = 0.001$) and employment status ($p = 0.001$). The higher mean rank of DHL search, content, reliability, relevance, and privacy was found among participants who were age>60 years widows, had primary education, and who were not employed. Statistically significant results were

noted for DHL content, reliability, relevance, and privacy by marital status, educational status, and employment status ($p < 0.05$). A statistically significant difference was observed in DHL contents with respect to household income ($p = 0.001$).

Post-hoc analysis of all the factors which were significant in Kruskal Walis test is displayed in Table 3.

Table 4 shows the results for means of the health information-seeking behavior by participants' characteristics using the Mann-Whitney U test/Kruskal Walis test. Health information-seeking behavior regarding how often the respondents read information about COVID-19 on the internet was significantly associated with age, marital status, educational status, and employment status ($p < 0.05$). Respondents' confidence in the accuracy of the information they read about COVID-19 on social media was found to be significantly

TABLE 4 Comparison of participants' characteristics and health information-seeking behavior (n = 301).

Characteristics	Health information-seeking behavior	
	How often do you read information about COVID-19 on the internet?	I am confident with the accuracy of the information I read about COVID-19 on social media.
Age groups		
≤20 years	166.28	229.98
21–25 years	167.79	224.88
>25 years	199.50	178.14
p-value	0.027*	0.001*
Gender		
Male	195.38	185.89
Female	187.99	194.50
p-value	0.494	0.44
Marital status		
Single	164.62	222.93
Married	202.86	173.86
Divorced	182.93	256.93
Widowed	269.38	107.32
Single parent	171.32	215.32
p-value	0.001*	0.001*
Educational level		
Primary	268.23	122.97
Secondary	202.53	168.37
Post-secondary education (pre-university/Diploma)	169.53	221.80
Tertiary education (Degree/Master)	160.56	223.74
p-value	0.001*	0.001*
Employment status		
Employed	182.59	196.12
Not employed	230.02	147.39
Student	162.65	235.77
p-value	0.001*	0.001*
Household income		
< RM2,500 (B1)	200.26	182.82
RM2,501 – RM3,169 (B2)	182.75	196.45
RM3,170 – RM3,969 (B3)	188.09	206.85
RM3,970 – RM4,849 (B4)	155.08	214.54
p-value	0.08	0.26

Data presented as mean rank.
Mann-Whitney U test/Kruskal Walis test was applied.
* Significant at 0.05 level of significance.

TABLE 5 Linear relationship between overall DHL and health information-seeking behavior (n = 301).

Health information-seeking behavior	β (95% CI)	*p*-value
How often do you read information about COVID-19 on the internet?	3.01 (2.74 to 3.28)	0.001*
I am confident with the accuracy of the information I read about COVID-19 on social media	−2.01 (−2.22 to −1.79)	0.001*

Linear regression was applied.
* Significant at 0.05 level of significance.

TABLE 6 Multivariate linear regression model for overall DHL and health information seeking behavior adjusted for covariates (n = 301).

Health information-seeking behavior	β (95% CI)	*p*-value
How often do you read information about COVID-19 on the internet?	2.124 (1.73 to 2.52)	0.001*
I am confident with the accuracy of the information I read about COVID-19 on social media.	−0.846 (−1.13 to −0.56)	0.001*

Multivariate linear regression was applied.
* Significant at 0.05 level of significance.
Model adjusted for age, gender, marital status, educational status., employment status and household income.

associated with age, marital status, educational level, and employment status.

Among participants, overall DHL increased by 3.01 score when frequency of reading health information about COVID-19 on the internet increased by one score ($\beta = 3.01$, 95% CI = 2.74 to 3.28). Whereas, overall DHL decreased by 2.01 score when confidence in the accuracy of the information on the internet regarding COVID-19 increased by one score ($\beta = -2.01$, 95% CI = −2.22 to −1.79) (Table 5).

Multivariate linear regression revealed that health information-seeking behavior remained statistically associated with overall DHL even after adjusting for covariates like age, gender, marital status, educational status, employment status and household income. The adjusted R^2 shows that independent variables can explain 60% of the variance in overall DHL (Table 6).

Discussion

The present study examines the impact of online health information-seeking behaviors on DHL related to COVID-19 among the B40 lower-income group in Selangor, Malaysia. The DHL increased with the frequency of reading information about COVID-19 on the internet and reduced with the reduced

confidence about the accuracy of the COVID-19 information searched for.

It was elementary for participants to search for information on the internet (39.1%) compared with other components of DHL, such as adding self-generated content, evaluating reliability, or protecting privacy. This can lead to many individuals searching for and finding low-quality information that can lead to improper self-management of COVID-19 symptoms, as reported in other countries (38). There is also the risk of a breach of privacy to information of these individuals with the lowest socio-economic status in the country being targeted by internet scammers. Individuals in the B40 categories easily become pray to scammers because they are not used to using the internet and its associated tools making them have lower levels of DHL compared to other income groups. For example, previous researchers in other parts of the globe have identified lower levels of DHL among individuals in the B40 categories (39). To the extent that individuals in developed countries use digital health tools to monitor their health making digital platforms, user friendly for many individuals not in the B40 categories (40). This is mainly attributed to high-income and middle-income earners/countries having better access to technology and health facilities than the B40 lower-income group. This makes the better earners used to the internet and knowing the trusted sources of where to search for information.

In the analysis concerning participant characteristics and the levels of DHL, the widowed statistically had a higher mean of DHL content, relevance, reliability, and privacy than other marital statuses. This may be due to widows using platforms to seek support, or to inform others about their sorrows and worries, as a means of coping with the loss of a loved one (41–43). The constant use made their literary higher in most aspects of DHL, especially concerning COVID-19. However, the widow(er)s were least confident in the information obtained.

Study findings showed that DHL decreased with increasing level of education, a finding contradictory with previous studies (44, 45). This may be due to differences in the participants recruited in the previous studies, i.e., Adil et al. (45) university students that excluded community members and Flynn et al. (44) was conducted before the internet became popular among individuals with lower levels of education (44, 46). There are inconsistent findings around the extent of vaccine hesitancy by the level of education, suggesting that political variables are important confounders when considering education. For example, the government will often be responsible for the public health messages around COVID-19 vaccination through the Ministry of Health. Research from Ghana shows that if the individual voted for the opposition party, trust in the messaging is lower, with increased hesitancy (47). The delivery of public health messaging is important, and thus here, similar behavior may affect how people choose to search for and receive the required information. Also, the controversial finding with level

of education and DHL may be due to use of a tool used to measure DHL that was not previously validated in similar a population; despite the good content and face validity.

The increase in DHL over the years may explain the higher DHL related to COVID-19 among unemployed individuals (46). Generally, many individuals are finding digital platforms more user friendly, with the migration to a digital era, and during the COVID-19 pandemic people explored the digital platforms for information and updates than any previous period. In addition, unemployed individuals may be exposed to more information online due to having adequate time spent online searching for employment. Here, participants earning a lower wage added increasing amounts of DHL content, whilst reading information about COVID-19 increased with age in the present study. This may be due to many older individuals being more concerned about the likely severity of illness and mortality in their populations and thus seeking out information on how best to protect themselves (48). Other demographics, for example, bereaved or widowed individuals, are potentially psychologically vulnerable to misinformation, so there is a fundamental importance to ensure that these groups can easily access appropriate health content.

Many individuals/groups with higher DHL were also reading more about COVID-19, but the more information they read, the lower their confidence in the information got. Individuals who get access to a lot of information find many contradictory findings, making them not confident of the information they read. They may be exposed to good and bad public health messaging but also see genuine uncertainties within the knowledge base, making it harder for an individual to make the best possible decisions. Due to the effect of the pandemic, such as emerging new variants, treatments, and vaccines (49), an increase in health information-seeking behaviors was associated with increased reading about COVID-19 information. Similar to other studies done during the pandemic, an increase in health information-seeking behaviors was associated with reduced confidence in the information obtained on social media (50–52). Social media has been the main source of spreading wrong information during the pandemic, especially by individuals who are against the vaccines and the lockdown protocols (53). Such misinformation on these social media platforms may also hinder the acceptance of good public health messaging.

This study has a few limitations. The first pertains to the use of convenience sampling and its cross-sectional nature. It cannot, therefore, be used to infer causality. Second, data were collected from participants' self-reports; thus, these may be subjected to socially desirable responses, and recall bias is common. Despite these limitations, the study data contribute to the understanding of the influence of DHL on health information-seeking behavior.

Conclusion

The present study examines the impact of online health information-seeking behaviors on DHL related to COVID-19 among the B40 income group in Malaysia. An inverse relationship was found between confidence in the accuracy of the information on the internet regarding COVID-19 and DHL. It is important to support lower-income demographics to assist access to high-quality health information, including less educated, unemployed, and widowed populations in order to improve overall DHL.

Further research could replicate this study with other populations, and longitudinal studies could consider how temporal trends around health information-seeking behavior, for example, across the pandemic and also outside of times of public health emergencies. Authorities and health promotion teams can use the information here to consider pandemic strategies around health promotion in lower-income demographics in Malaysia.

Data availability statement

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

Ethics statement

The studies involving human participants were reviewed and approved by Ethics Committee of Management and Science University (Ethics Code: MSU-RMC-02/FR01/09/L1/085). The patients/participants provided their written informed consent to participate in this study.

Author contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas, took part in drafting, revising or critically reviewing the article, gave final approval of the version to be published, have agreed on the journal to which the article has been submitted, and agree to be accountable for all aspects of the work.

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

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References

1. The Wellness Network. *Digital Health Literacy Key Component to Improved Health Outcomes.* (2020). Available online at: https://www.thewellnessnetwork.net/health-news-and-insights/blog/digital-health-literacy/ (accessed July 10, 2022).

2. Eysenbach G. *Improving the Quality of Web Surveys: the Checklist for Reporting Results of Internet E-Surveys.* (2012). Available online at: https://www.jmir.org/2012/1/e8/ (accessed July 9, 2022).

3. Kaihlanen AM, Virtanen L, Buchert U, Safarov N, Valkonen P, Hietapakka L, et al. Towards digital health equity-a qualitative study of the challenges experienced by vulnerable groups in using digital health services in the COVID-19 era. *BMC Health Serv Res.* (2022) 22:1–12. doi: 10.1186/s12913-022-07584-4

4. WHO. *Refugee and Migrant Health.* Available online at: https://www.who.int/news-room/fact-sheets/detail/refugee-and-migrant-health (accessed August 14, 2022).

5. WHO. *Social Media & COVID-19: A global study of digital crisis interaction among Gen Z and Millennials.* (2021). Available online at: https://www.who.int/news-room/feature-stories/detail/social-media-covid-19-a-global-study-of-digital-crisis-interaction-among-gen-z-and-millennials (accessed August 14, 2022).

6. Rocha YM, de Moura GA, Desidério GA, de Oliveira CH, Lourenço FD, de Figueiredo Nicolete LD. The impact of fake news on social media and its influence on health during the COVID-19 pandemic: a systematic review. *Z Gesundh Wiss.* (2021) 1–10. doi: 10.1007/s10389-021-01658-z

7. WHO. Immunizing the Public Against Misinformation (2020). Available online at: https://www.who.int/news-room/feature-stories/detail/immunizing-the-public-against-misinformation (accessed August 14, 2022).

8. WHO. *Ten Health Issues WHO Will Tackle This Year.* (2019). Available online at: https://www.who.int/news-room/spotlight/ten-threats-to-global-health-in-2019 (accessed August 14, 2022).

9. Cascini F, Pantovic A, Al-Ajlouni YA, Failla G, Puleo V, Melnyk A, et al. Social media and attitudes towards a COVID-19 vaccination: a systematic review of the literature. *EClinicalMedicine*. (2022) 48:101454. doi: 10.1016/j.eclinm.2022.101454

10. Mtewa AG, Ndege N, Atela J, Alam U, Kinyanjui S. *Media Influence on COVID-19 Vaccine Hesitancy and Uptake in Africa: A Rapid Systematic Review*. Available online at: https://www.aasciences.africa/sites/default/files/inline-files/Vaccine%20hesitancy%20poilcy%20brief_revised_EM.pdf

11. Rotolo B, Dubé E, Vivion M, MacDonald SE, Meyer SB. Hesitancy towards COVID-19 vaccines on social media in Canada. *Vaccine*. (2022) 40:2790–6. doi: 10.1016/j.vaccine.2022.03.024

12. Parimi K, Gilkeson K, Creamer BA. COVID-19 vaccine hesitancy: considerations for reluctance and improving vaccine uptake. *Hum Vaccin Immunother*. (2022) 18:2062972. doi: 10.1080/21645515.2022.2062972

13. Odone A, Gianfredi V, Sorbello S, Capraro M, Frascella B, Vigezzi GP, et al. The use of digital technologies to support vaccination programmes in Europe: state of the art and best practices from experts' interviews. *Vaccines*. (2021) 9:1126. doi: 10.3390/vaccines9101126

14. Marzo RR, Khanal P, Ahmad A, Rathore FA, Chauhan S, Singh A, et al. Quality of life of the elderly during the COVID-19 pandemic in Asian Countries: a cross-sectional study across six countries. *Life*. (2022) 12:365. doi: 10.3390/life12030365

15. RilleraMarzo R, Villanueva EQ, Chandra U, Htay MNN, Shrestha R, Shrestha S. Risk perception, mental health impacts and coping strategies during COVID-19 pandemic among Filipino healthcare workers. *J Public Health Res*. (2021) 10:jphr.2021.2604. doi: 10.4081/jphr.2021.2604

16. Marzo RR, Vinay V, Bahari R, Chauhan S, Ming DAF, Fernandez SFAN, et al. Depression and anxiety in Malaysian population during third wave of the COVID-19 pandemic. *Clin Epidemiol Glob Health*. (2021) 12:100868. doi: 10.1016/j.cegh.2021.100868

17. Kamberi F, Sinaj E, Jaho J, Subashi B, Sinanaj G, Jaupaj K, et al. Impact of COVID-19 pandemic on mental health, risk perception and coping strategies among health care workers in Albania - evidence that needs attention. *Clin Epidemiol Glob Health*. (2021) 12:100824. doi: 10.1016/j.cegh.2021.100824

18. Htay MNN, Marzo RR, Bahari R, AlRifai A, Kamberi F, El-Abasiri RA, et al. How healthcare workers are coping with mental health challenges during COVID-19 pandemic? - A cross-sectional multi-countries study. *Clin Epidemiol Glob Health*. (2021) 11:100759. doi: 10.1016/j.cegh.2021.100759

19. Htay MNN, Marzo RR, AlRifai A, Kamberi F, El-Abasiri RA, Nyamache JM, et al. Immediate impact of COVID-19 on mental health and its associated factors among healthcare workers: a global perspective across 31 countries. *J Glob Health*. 10:020381. doi: 10.7189/jogh.10.020381

20. Marzo RR, Aye SS, Naing TW, Kyaw TM, Win MT, Soe HHK, et al. Factors associated with psychological distress among Myanmar residents during COVID-19 pandemic crises. *J Public Health Res*. (2021) 10:jphr-2021. doi: 10.4081/jphr.2021.2279

21. Marzo RR, Ismail Z, Htay MNN, Bahari R, Ismail R, Villanueva III EQ, et al. Psychological distress during pandemic Covid-19 among adult general population: Result across 13 countries. *Clin Epidemiol Glob Health*. (2021) 10:100708. doi: 10.1016/j.cegh.2021.100708

22. Marzo RR, Singh A, Mukti RF. A survey of psychological distress among Bangladeshi people during the COVID-19 pandemic. *Clin Epidemiol Glob Health*. (2021) 10:100693. doi: 10.1016/j.cegh.2020.100693

23. Abasiri RAE, RilleraMarzo R, Abdelaziz H, SherifBoraii, Abdelaziz H. Evaluating the psychological distress of the coronavirus disease 2019 pandemic in Egypt. *Eur J Mol Clin Med*. (2020) 7:1–12.

24. Marzo RR, Villanueva III EQ, Faller EM, Baldonado AM. Factors associated with psychological distress among Filipinos during coronavirus disease-19 pandemic crisis. *Open Access Maced J Med Sci*. (2020) 8:309–13. doi: 10.3889/oamjms.2020.5146

25. Respati T, Irasanti SN, Sartika D, Akbar IB, Marzo RR. A nationwide survey of psychological distress among Indonesian residents during the COVID-19 pandemic. *Int J Public Health Sci*. (2021) 10:119–26. doi: 10.11591/ijphs.v10i1.20609

26. Marzo RR, Ahmad A, Islam MS, Essar MY, Heidler P, King I, et al. Perceived COVID-19 vaccine effectiveness, acceptance, and drivers of vaccination decision-making among the general adult population: a global survey of 20 countries. *PLoS Negl Trop Dis*. (2022) 16:e0010103. doi: 10.1371/journal.pntd.0010103

27. Marzo RR, Sami W, Alam MdZ, Acharya S, Jermsittiparsert K, Songwathana K, et al. Hesitancy in COVID-19 vaccine uptake and its associated factors among the general adult population: a cross-sectional study in six Southeast Asian countries. *Trop Med Health*. (2022) 50:4. doi: 10.1186/s41182-021-00393-1

28. Elsayed M, El-Abasiri RA, Dardeer KT, Kamal MA, Htay MNN, Abler B, et al. Factors influencing decision making regarding the acceptance of the COVID-19 vaccination in Egypt: a cross-sectional study in an urban, well-educated sample. *Vaccines*. (2022) 10:20. doi: 10.3390/vaccines10010020

29. Marzo RR, Ahmad A, Abid K, Khatiwada AP, Ahmed A, Kyaw TM, et al. Factors influencing the acceptability of COVID-19 vaccination: a cross-sectional study from Malaysia. *Vacunas*. (2022) 23:S33–40. doi: 10.1016/j.vacun.2021.07.007

30. King I, Heidler P, Marzo RR. The long and winding road: uptake, acceptability, and potential influencing factors of COVID-19 vaccination in Austria. *Vaccines*. (2021) 9:790. doi: 10.3390/vaccines9070790

31. Pertwee E, Simas C, Larson HJ. An epidemic of uncertainty: rumors, conspiracy theories and vaccine hesitancy. *Nat Med*. (2022) 28:456–9. doi: 10.1038/s41591-022-01728-z

32. Malaysia COVID-19. *Malaysia COVID - Coronavirus Statistics - Worldometer*. (2022). Available online at: https://www.worldometers.info/coronavirus/country/malaysia/ (accessed August 14, 2022).

33. Reuters. *Malaysia: The Latest Coronavirus Counts, Charts and Maps*. (2022). Available online at: https://graphics.reuters.com/world-coronavirus-tracker-and-maps/countries-and-territories/malaysia/ (accessed August 14, 2022).

34. Team Loanstreet. *Malaysia's Income Classifications: What's B40, M40 & T20?*. (2022). Available online at: https://loanstreet.com.my/learning-centre/malaysia-household-income-classification-b40-m40-t20 (accessed August 14, 2022).

35. Prudential. *Malaysia Leads the Way in the Adoption of Digital Healthcare in Prudential's New Asia-wide Research*. (2022). Available online at: https://www.prudential.com.my/en/our-company-newsroom/press-release/2021-malaysia-leads-the-way-in-the-adoption-of-digital-healthcare-in-prudentials-new-asia-wide-research/index.html (accessed August 14, 2022).

36. Jafar A, Dambul R, Dollah R, Sakke N, Mapa MT, Joko EP. COVID-19 vaccine hesitancy in Malaysia: exploring factors and identifying highly vulnerable groups. *PLoS ONE*. (2022) 17:e0270868. doi: 10.1371/journal.pone.0270868

37. Vaart R. van der, Drossaert C. Development of the digital health literacy instrument: measuring a broad spectrum of health 10 and health 20 skills. *J Med Internet Res*. (2017) 19:e6709. doi: 10.2196/jmir.6709

38. Kaggwa MM, Bongomin F, Najjuka SM, Rukundo GZ, Ashaba S. Cannabis-induced mania following CoViD-19 self-medication: a wake-up call to improve community awareness. *Int Med Case Rep J*. (2021) 14:121. doi: 10.2147/IMCRJ.S301246

39. Azzopardi-Muscat N, Sørensen K. Towards an equitable digital public health era: promoting equity through a health literacy perspective. *Eur J Public Health*. (2019) 29:13–7. doi: 10.1093/eurpub/ckz166

40. Nouri SS, Adler-Milstein J, Thao C, Acharya P, Barr-Walker J, Sarkar U, et al. Patient characteristics associated with objective measures of digital health tool use in the United States: a literature review. *J Am Med Info Assoc*. (2020) 27:834–41. doi: 10.1093/jamia/ocaa024

41. Bovero A, Tosi C, Botto R, Fonti I, Torta R. Death and dying on the social network: an Italian survey. *J Soc Work End Life Palliat Care*. (2020) 16:266–85. doi: 10.1080/15524256.2020.1800552

42. Gilbert KR, Horsley GC. Technology and grief support in the twenty-first century: a multimedia platform. In: *Grief and Bereavement in Contemporary Society Routledge*. New York. (2021).

43. Sofka C. The transition from life to the digital afterlife: thanatechnology and its impact on grief. In: *Digital Afterlife Chapman and Hall/CRC*, New York. (2020). doi: 10.1201/9780429322198-5

44. Flynn KE, Smith MA, Freese J. When do older adults turn to the internet for health information? Findings from the Wisconsin Longitudinal Study. *J Gen Intern Med*. (2006) 21:1295–301. doi: 10.1111/j.1525-1497.2006.00622.x

45. Adil A, Usman A, Khan NM, Mirza FI. Adolescent health literacy: factors effecting usage and expertise of digital health literacy among universities students in Pakistan. *BMC Public Health*. (2021) 21:1–6. doi: 10.1186/s12889-020-10075-y

46. Eshet-Alkalai Y, Chajut E. Changes over time in digital literacy. *CyberPsychol Behav*. (2009) 12:713–5. doi: 10.1089/cpb.2008.0264

47. Brackstone K, Atengble K, Head M, Boateng L. Examining drivers of COVID-19 vaccine hesitancy: measuring the roles of political allegiance, misinformation beliefs, and sociodemographic factors. (2022). Available online at: https://www.medrxiv.org/content/10.1101/2022.03.16.22272463v1 (accessed July 9, 2022).

48. Casas-Deza D, Bernal-Monterde V, Aranda-Alonso AN, Montil-Miguel E, Julián-Gomara AB, Letona-Giménez L, et al. Age-related mortality in 61,993 confirmed COVID-19 cases over three epidemic waves in Aragon, Spain. Implications for vaccination programmes. *PLoS ONE*. (2021) 16:e0261061. doi: 10.1371/journal.pone.0261061

49. Koyama T, Weeraratne D, Snowdon JL, Parida L. Emergence of drift variants that may affect COVID-19 vaccine development and antibody treatment. *Pathogens.* (2020) 9:324. doi: 10.3390/pathogens9050324

50. Bak CK, Krammer JØ, Dadaczynski K, Orkan O, von Seelen J, Prinds C, et al. Digital health literacy and information-seeking behavior among university college students during the COVID-19 pandemic: a cross-sectional study from Denmark. *Int J Environ Res Public Health.* (2022) 19:3676. doi: 10.3390/ijerph19063676

51. Benis A, Khodos A, Ran S, Levner E, Ashkenazi S. Social media engagement and influenza vaccination during the COVID-19 pandemic:

cross-sectional survey study. *J Med Internet Res.* (2021) 23:e25977. doi: 10.2196/25977

52. Neely S, Eldredge C, Sanders R. Health information seeking behaviors on social media during the COVID-19 pandemic among American social networking site users: survey study. *J Med Internet Res.* (2021) 23:e29802. doi: 10.2196/29802

53. Barua Z, Barua S, Aktar S, Kabir N, Li M. Effects of misinformation on COVID-19 individual responses and recommendations for resilience of disastrous consequences of misinformation. *Prog Disaster Sci.* (2020) 8:100119. doi: 10.1016/j.pdisas.2020.100119

Digital health literacy for COVID-19 vaccination and intention to be immunized: A cross sectional multi-country study among the general adult population

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Introduction: It is clear that medical science has advanced much in the past few decades with the development of vaccines and this is even true for the novel coronavirus outbreak. By late 2020, COVID-19 vaccines were starting to be approved by national and global regulators, and across 2021, there was

a global rollout of several vaccines. Despite rolling out vaccination programs successfully, there has been a cause of concern regarding uptake of vaccine due to vaccine hesitancy. In tackling the vaccine hesitancy and improving the overall vaccination rates, digital health literacy (DHL) could play a major role. Therefore, the aim of this study is to assess the digital health literacy and its relevance to the COVID-19 vaccination.

Methods: An internet-based cross-sectional survey was conducted from April to August 2021 using convenience sampling among people from different countries. Participants were asked about their level of intention to the COVID-19 vaccine. Participants completed the Digital Health Literacy Instrument (DHLI), which was adapted in the context of the COVID Health Literacy Network. Cross-tabulation and logistic regression were used for analysis purpose.

Results: Overall, the mean DHL score was 35.1 (SD = 6.9, Range = 12−48). The mean DHL score for those who answered "Yes" for "support for national vaccination schedule" was 36.1 (SD 6.7) compared to 32.5 (SD 6.8) for those who either answered "No" or "Don't know". Factors including country, place of residence, education, employment, and income were associated with the intention for vaccination. Odds of vaccine intention were higher in urban respondents (OR-1.46; C.I.-1.30−1.64) than in rural respondents. Further, higher competency in assessing the relevance of online information resulted in significantly higher intention for vaccine uptake.

Conclusion: Priority should be given to improving DHL and vaccination awareness programs targeting rural areas, lower education level, lower income, and unemployed groups.

Introduction

The COVID-19 pandemic, in which confirmed cases first appeared in China and the outbreak quickly has spread across the globe, was defined as a Public Health Emergency of International Concern on January 30, 2020. The World Health Organization (WHO) officially declared a pandemic on March 11, 2020. The pandemic has since resulted in a significant level of excess deaths and a huge socio-economic impact on countries around the world. During the earlier phases of the pandemic, many countries implemented precautionary measures such as mask wearing, quarantines, and curfews to slow the spread of the virus. These measures were effective in reducing both transmission and the overall burden of COVID-19 disease (1). However, research has conclusively shown that COVID-19 has severe health effects including quality of life (2), mental health (3–7), and psychological distress (8–13).

Since the start of the first outbreak in early 2020, there has been significant commentary about COVID-19 on social media, in which users have been exposed to good and bad quality information about the virus and the emerging outbreaks. In light of the significant amount of false information coming from digital platforms amidst the pandemic, the WHO introduced a new term—an infodemic—defined as "too much information including false or misleading information in digital and physical environments during a disease outbreak". The WHO urged all nations to combat the COVID-19 infodemic (1).

By late 2020, COVID-19 vaccines were starting to be approved by national and global regulators, and across 2021, there was a global rollout of several vaccine candidates, including those manufactured by Pfizer and AstraZeneca. Since then, countries have urgently attempted to reach their populations and achieve high vaccine uptake. Mortality rates and cases numbers have fallen dramatically as a result of vaccination (14, 15). By reducing the pressures on national and local health services, immunization programs have helped the countries in easing down restrictions, and enabled people to resume their normal lives (16). Nevertheless, the virus is still highly prevalent around the world, with new variants fueling transmission, and too many people still awaiting access to even their first

dose of any COVID-19 vaccine. As a result of misinformation and vaccine efficacy, vaccine hesitancy also plagued the global COVID-19 vaccination program (16–18). The acceptance of vaccine was further influenced by the recommendations of medical professionals (19, 20).

Vaccine hesitancy has been an important area of concern when considering pandemic response strategies. The main cause of vaccine hesitancy is misinformation that affects decision-making and causes hesitation in vaccination uptake (17). In a systematic review conducted by Cascini et al., a negative association between use of social media and people's intention to vaccinate themselves have been observed (21). Decisions to receive vaccination has been greatly impacted by the exposure to false information on social media. A further study conducted in Ghana, shows the influence of social media on the people's belief about vaccination (22). Additionally, people in Southeast Asia have become hesitant to vaccination due to the existence of misinformation through digital platforms (23). It is therefore important to acknowledge the use of social media as a tool through which misinformation can easily be spread. On the other hand, Morocco, a country located in North Africa has used its digital system to run a smart vaccination campaign. This digital system comprises a vaccination registry, stock, logistics management facilities, and a portal for tracking side effects of the vaccine. In addition, a new platform named "liqah" ("vaccine" in "Arabic") has been established, which allows doctors to communicate directly with the citizens. The website also shares comprehensive information on the vaccines for the citizens (24). In a study conducted in eight European countries, it is shown that digital technologies and tools have supported the vaccination programs. Digital tools were used to convey information about the safety and efficacy of vaccines and how to access vaccine services (25). Digital health tools can also help with vaccine hesitancy. In order to do this, information from the platform should be conveyed in multiple languages, clearer language, and in a friendly manner. Moreover, the engagement platforms should be trustworthy and provide greater details for people who are in the greatest need of vaccine. Additionally, digital health tools should be inclusive and embrace all races and ethnicities (26).

People are increasingly using electronic resources to make decisions about their health, including social media, demonstrating the importance of digital health literacy (27). The WHO defines Digital Health Literacy as the ability to utilize electronic devices to gain, seek, appraise, and comprehend health information in order to improve health outcomes or address a health concern (28). Digital platforms are ideal places to communicate accurate information about COVID-19. However, social media platforms have become a hub of misinformation negatively impacting people's lives and attitudes concerning the pandemic. Monitoring digital platforms is essential toward ensuring that people have access to the best possible information at the appropriate time. To assess digital health literacy and its relevance to the COVID-19 vaccination, a cross-sectional study was conducted in 11 countries among the general adult population.

Methods

Study design

An internet-based cross-sectional survey was conducted from April to August 2021 using non-random convenience sampling among people from different countries.

Data collection procedures

The sample size is estimated with an infinite population, a confidence level of 95%, a Z score of 1.960, and a margin error of 0.05. We distributed the Google form online without restriction for the specific country using personal contacts by emails, web-based applications (e.g., WhatsApp and Telegram), and social media (e.g., Facebook, LinkedIn, Twitter, and Instagram); over 4,700 subjects completed the surveys. Participants confirmed that they were aged 18 years or older. They were reminded to respond only once and use a unique identifier to create a single account by settings that allow one response per user. Finally, personal data protection was emphasized during the study to secure our data's privacy, availability, and integrity. Confidentiality and privacy of participants' responses were ensured to minimize potential bias caused by self-reported data. Data were collected using the online Google Forms platform. The collected information was exported for review in Microsoft Excel before a fuller analysis using Stata 16 (College Station, TX: StataCorp LLC).

Instrument development and measures

The questionnaire was adapted from the World Health Organization's (WHO) survey tool and guidance on COVID-19 (29). This survey tool monitors knowledge, risk perceptions, preventive behaviors including digital health literacy, and other variables to inform COVID-19 outbreak response measures, including policies, interventions, and communications.

Demographics

Data collected included socio-demographic characteristics of participants, including as age, gender, education (secondary or less/post-secondary/tertiary), country of residence (the focus being Bangladesh, Brazil, Egypt, Indonesia, Iran, Malaysia, Myanmar, Philippines, Thailand, Turkey, United Arab Emirates, others), religion (Islam, Buddhism, Christianity, Hinduism, others), community type (rural/urban), employment status (working/not employed/unemployed/student), and income (self-reported as sufficient/less sufficient).

TABLE 1 Socio-demographic characteristics of respondents.

	n	%
Age group		
18–29	3,115	66.3
30–49	1,141	24.3
50 and above	444	9.4
Gender		
Male	1,983	42.2
Female	2,717	57.8
Education level		
Up to secondary	1,427	30.4
Tertiary	3,273	69.6
Country		
Bangladesh	175	3.7
Brazil	140	3.0
Egypt	106	2.3
Indonesia	321	6.8
Iran	256	5.4
Malaysia	1,556	33.1
Myanmar	69	1.5
Philippines	919	19.6
Thailand	117	2.5
Turkey	586	12.5
United Arab Emirates	310	6.6
Other	145	3.1
Religion		
Islam	2,723	57.9
Buddhism	412	8.8
Christianity	1,158	24.6
Hinduism	273	5.8
Other	134	2.9
Community type		
Rural	1,546	32.9
Urban	3,154	67.1
Employment status		
Working	2,047	43.6
Not working	1,314	28.0
Student	906	19.3
Other	433	9.2
How sufficient do you consider your income?[#]		
Sufficient	3,181	68.3
Less sufficient	1,480	31.8

[#]Missing income information, n = 39.

Vaccine intention

Participants were asked about their level of intention to the COVID-19 vaccine ("I think everyone should be vaccinated according to the National vaccination schedule"; no, I don't know, yes).

Digital health literacy

Participants completed the Digital Health Literacy Instrument (DHLI) (8), which was adapted in the context of the COVID Health Literacy Network. The scale measures one's ability to seek, find, understand, and appraise health information from digital resources. While the original DHLI is comprised of 7 subscales, this study used the following four domains: (1) information searching or using appropriate strategies to look for information (e.g., "When you search the internet for information on coronavirus virus or related topics, how easy or difficult is it for you to find the exact information you are looking for?") (2) adding self-generated content to online-based platforms (e.g., "When typing a message on a forum or social media such as Facebook or Twitter about the coronavirus a related topic, how easy or difficult is it for you to express your opinion, thought, or feelings in writing?") (3) evaluating reliability of online information (e.g., "When you search the internet for information on the coronavirus or related topics, how easy or difficult is it for you to decide whether the information is reliable or not?") and (4) determining relevance of online information [e.g., "When you search the internet for information on the coronavirus or related topics, how easy or difficult is it for you to use the information you found to make decisions about your health (protective measures, hygiene regulations, transmission routes, risks and their prevention)?"]. A total of 12 items (three per each dimension) were asked, and answers were recorded on a four-point Likert scale (1 = *very difficult*; 4 = *very easy*). The reliability statistics (Cronbach alpha) for the overall DHL score was 0.92 while the alpha coefficients for the four subscales ranges from 0.73 to 0.88, suggesting acceptable to good internal consistency (30). Only participants who had complete data on all DHL subscales were included in the final analysis.

Ethics statement

The study was designed and conducted in line with the declaration of Helsinki and was approved by the Asia Metropolitan University Ethics Committee in Malaysia (Ref. No: AMU/MREC/NF/18022021). Respondents were informed that their participation was voluntary, and written consent was implied on the completion of the questionnaire. All participants were aged 18 years or older.

Statistical analysis

Descriptive analysis was conducted for socio-demographic variables. Continuous variables were presented as mean (standard deviation, SD). The outcome variable, vaccine intention, were dichotomized to "Yes" and "No/Don't know" while the DHL sub-scales and overall scores were dichotomized

to "sufficient" vs. "limited" by median split in the analysis. Bivariate analyses between the socio-demographic variables and the DHL variables, and the vaccine intention were displayed using cross-tabulations and Chi-squared statistics were reported for statistical significance ($p < 0.05$). Multivariable logistic regression with robust variance were used to see associations between DHL overall (model 1) and DHL subscales (model 2) with vaccine intention, adjusted for age, sex, education, country, urban/rural, employment status and income. The variable "religion" was not included in the final models due to multicollinearity. Assumptions for logistic regression were met and multicollinearity was checked using variation inflation factor (VIF). Adjusted odds ratios (AOR, 95%CI) were reported in the models with the Hosmer-Lemeshow test reported for model fit. All analyses were conducted using Stata 16 (College Station, TX: StataCorp LLC).

Results

The survey was completed by 4700 participants from 53 countries. The mean age was 29.4 (SD = 11.9 years), with range of 18–77 years. The majority of respondents were 18–29 years old (66%), female (58%), had tertiary level education (70%), and from Malaysia (33%). Other socio-demographic characteristics of the participants are summarized in Table 1.

Overall, the mean DHL score was 35.1 (SD = 6.9, Range = 12–48). The mean DHL score for those who answered "Yes" for "support for national vaccination schedule" was 36.1 (SD 6.7) compared to 32.5 (SD 6.8) for those who either answered "No" or "Don't know", $t_{(4,587)} = 16.0$, $p < 0.001$. The median for all the subscales scores were 9.0, 9.0, 9.0, and 9.0 (range 3–12), respectively, while the median for the total DHL score was 35.0 (range 12–48). The percentages of having "intention to get an immunization" within categories of socio-demographic characteristics and DHL sufficiency cut-off are displayed in Table 2.

Multivariable models

The multivariable logistic regression with robust variance models are shown in Table 3. The predictors of interest are sufficient (Sufficient vs. Limited) DHL score (Model 1) and each of the four subscales median cut-off (Model 2). After adjustment for age, sex, education, country, urban/rural, employment status and income, the Adjusted Odds Ratio (AOR) for intention to vaccination was 1.64 (95% CI, 1.41–1.90) for sufficient DHL. In Model 2, only subscale 4 (determining relevance) was a statistically significant factor for predicting intention to vaccination, AOR 1.48 (95% CI, 1.21–1.80).

TABLE 2 Bivariate associations between socio-demographic characteristics and sufficient DHL, with intention for vaccination.

	"I think everyone should be vaccinated according to the national vaccination schedule"				
	Yes		**No/don't know**		
	n	**%**	***n***	**%**	χ^2, ***p*-value**
Age group					
18–29	2,113	67.8	1,002	32.2	109.409, $p < 0.001$
30–49	890	78.0	251	22.0	
50 and above	394	88.7	50	11.3	
Sex					
Male	1,468	74.0	515	26.0	5.259, $p = 0.022$
Female	1,929	71.0	788	29.0	
Education level					
Up to secondary	943	66.1	484	33.9	39.234, $p < 0.001$
Tertiary	2,454	75.0	819	25.0	
Country					
Bangladesh	100	57.1	75	42.9	745.275, $p < 0.001$
Brazil	134	95.7	6	4.3	
Egypt	70	66.0	36	34.0	
Indonesia	289	90.0	32	10.0	
Iran	198	77.3	58	22.7	
Malaysia	1,199	77.1	357	22.9	
Myanmar	47	68.1	22	31.9	
Philippines	410	44.6	509	55.4	
Thailand	107	91.5	10	8.5	
Turkey	574	98.0	12	2.0	
United Arab Emirates	196	63.2	114	36.8	
Other	73	50.3	72	49.7	
Religion					
Islam	2,152	79.0	571	21.0	381.538, $p < 0.001$
Buddhism	333	80.8	79	19.2	
Christianity	581	50.2	577	49.8	
Hinduism	232	85.0	41	15.0	
Other	99	73.9	35	26.1	
Area of residence					
Rural	970	62.7	576	37.3	104.509, $p < 0.001$
Urban	2,427	76.9	727	23.1	
Employment status					
Working	1,597	78.0	450	22.0	220.061, $p < 0.001$
Not working	819	62.3	495	37.7	
Student	748	82.6	158	17.4	
Other	233	53.8	200	46.2	
How sufficient do you consider your income?					
Sufficient	2,375	74.7	806	25.3	29.359, $p < 0.001$
Less sufficient	992	67.0	488	33.0	
Sufficient DHL (total score)					
Limited	1,286	63.0	754	37.0	166.543, $p < 0.001$

(Continued)

TABLE 2 (Continued)

"I think everyone should be vaccinated according to the national vaccination schedule"

	Yes		No/don't know		
	n	%	*n*	%	χ^2, *p*-value
Sufficient	2,043	80.1	506	19.9	
Subscale 1: Information seeking					
Limited	1,066	61.4	669	38.6	161.694, $p < 0.001$
Sufficient	2,325	78.7	631	21.3	
Subscale 2: Adding self-generated content					
Limited	1,396	69.2	622	30.8	20.969, $p < 0.001$
Sufficient	1,951	75.2	642	24.8	
Subscale 3: Evaluating reliability					
Limited	1,294	63	761	37	159.181, $p < 0.001$
Sufficient	2,091	79.6	536	20.4	
Subscale 4: Determining relevance					
Limited	946	59.9	634	40.1	184.176, $p < 0.001$
Sufficient	2,441	78.6	663	21.4	

Missing values: Income (n = 39), total DHL score (n = 111), subscales 1 (n = 9), subscales 2 (n = 89), subscales 3 (n = 18), and subscales 4 (n = 16).

Discussion

This study provides insights into digital health literacy and its association with the intention of vaccination across 53 countries, but with a predominant focus on 11 countries. To the best of our knowledge, this is the first study to investigate the DHL and intention to vaccinate during the COVID-19 outbreak in a wider geographical area. Our findings indicated that respondents had a high overall score of digital health literacy ($M = 2.93$, $SD = 0.58$). Similarly, sufficient DHL levels were reported among the university student population in the US (31), Germany (32), Pakistan (33), Malaysia, China, and the Philippines (34). Although inclusion criteria covered the general population, the respondents were predominantly younger adults, and approximately 70% attained tertiary education, which may explain the similar level of DHL levels with previous studies. For instance, older adults were associated with lower digital health literacy level, limited utilization of technology and electronic devices, and lower confidence in using technology (35). During this digital era with the increasing speed of utilization, digital information sources have tremendous potential benefits to the population's health (36). Thus, attaining a sufficient level of DHL is a positive prospect for positive health behaviors, including combating and preventing COVID-19 infection.

From the perspective of public health, improving health literacy among the population is considered a social vaccine

to prevent, protect, and reduce the burden of diseases (37). During the COVID-19 pandemic, DHL is a critical tool to reduce the impact of the infodemic, and to improve the dissemination of high-quality pandemic-related information around topics such as preventive behaviors and vaccination (31, 33). Among our study respondents, those who supported being vaccinated according to the National Vaccination Schedule were found to have significantly higher digital health literacy scores compared to those who opposed this concept. Our findings are correlated with a previous study in the US, where a higher DHL level is associated with the willingness to have COVID-19 vaccination (38).

Among those who have sufficient DHL, some demographic factors were found to be associated with the intention to be vaccinated. In terms of geographic location, respondents from Turkey and Brazil reported having the significant highest intention compared to respondents from Bangladesh. The WHO are cooperating and collaborating with countries to ascertain equal access to the COVID-19 vaccination as it is the key factor to combat the pandemic (38). However, perception of vaccination, intention, and willingness plays a crucial role in the vaccine uptake during the pandemic. In a comparison across various countries, willingness to take the vaccination in low- and middle-income countries in Africa, South Asia, and Latin America was found to be an average of 80.3% in the previous study (39). In the UK, a similar finding of high willingness (88.8%) to take COVID-19 vaccination was reported (40). Meanwhile, in the US, 67% of the study respondents reported their willingness to vaccinate (41). Vaccine acceptance was found to be varied in previous studies across the UK, US, South Asia, Africa, and Latin America (39–41). Among the Canadian population, only 9% of the respondents in the nationwide survey reported that they had no intention to take COVID-19 vaccination (42). Different levels of intention for vaccine uptake across the countries might be contributed by the incidence of COVID-19 infection, public awareness level, and sampling recruitment in studies (43–46). Furthermore, willingness to take vaccination could be varied by contextual influence including politics and policies, individual and group influence, and vaccine-related factors such as the design and the delivery program, recommendations from healthcare personnel, and ability to understand (i.e., language and health literacy) (47). High willingness to vaccinate was reported among the Canadian community (42), where government policy was committed to vaccination by providing the financial, policy, and legislative support, by developing specific strategies for some groups including indigenous, pregnant, and persons with disabilities, minor ethnic groups and immigrants (48, 49). Political ideologies might also be related to vaccine uptake, as some states in the US achieved 70% vaccination, while another state reported only 35% of vaccination (49). Therefore, the local authorities need to understand the community perception, changes in that perception over time around the

TABLE 3   Adjusted ORs (95% CI) for sufficient total DHL score and sufficient DHL subscales scores in relation to "intention for vaccination"#.

	Sufficient DHL (Model 1)	Sufficient DHL subscales(Model 2)
Overall DHL	1.64*** (1.41, 1.90)	
Subscale 1: Information seeking		1.12 (0.92, 1.36)
Subscale 2: Adding self-generated content		1.10 (0.92, 1.30)
Subscale 3: Evaluating reliability		1.16 (0.95, 1.42)
Subscale 4: Determining relevance		1.48*** (1.21, 1.80)
Observations	4,553	4,553
Pseudo R^2	0.181	0.185
Hosmer-Lemeshow chi-squared	8.38 (df = 8), $p = 0.397$	2.68 (df = 8), $p = 0.953$

Adjusted for age, sex, education, country, urban/rural, employment status. and income.
#The outcome variable is "intention for vaccination", Yes = 1, No/Don't know = 0 (reference).
***$p < 0.001$.

willingness to vaccinate, and should have a strong political commitment. This is important not only for the COVID-19 vaccine, but also for all other nationally recommended vaccines. The WHO and UNICEF have highlighted a global rise of measles outbreaks in the first quarter of 2022, as population mixing begins to return to pre-pandemic levels but also after 2 years of interrupted healthcare (50). Thus, a proactive approach to health promotion around routine vaccinations is important.

Respondents who achieved tertiary education were more likely to take the vaccine compared to those who achieved up to secondary education. Education has been reported as one of the influencing factors on intention and willingness to vaccinate in previous studies (51–54), albeit with occasionally conflicting results. For example, a study in Ghana found that higher education was linked to increased hesitancy, rather than increased willingness to vaccinate, with political allegiance likely to be a confounding variable when considering education (55).

The community needs trustworthy information about the disease, including the benefits of physical and mental wellbeing. Since the digital media is the major source of information, competency in online information-searching and evaluating the validity and reliability of information are associated with the utilization of trustworthy information sources (34). People with higher education levels may search for scientifically established information with critical evaluation compared to lower education group regards to COVID-19 related information and vaccination (56, 57). Furthermore, urban residents, employed people, and those who have sufficient income are positively associated with the intention to vaccinate. Previous studies reported that demographic factors such as residency and income influence knowledge, perceptions, and acceptance of COVID-19 vaccination (17, 58).

During the COVID-19 pandemic, people have also searched for health information *via* the traditional media, including television channels, national newspapers, government webpages (34, 59). Traditional channels play an essential role in providing informed and evidence-based vaccine-related content. In the meantime, there is potential for social media to educate people and reduce vaccine hesitancy (59). In this study, the key finding was that determining relevance of COVID-19 information was a significant factor regarding the intention to vaccinate. Moreover, the mean score for determining the relevance domain was found to be the highest among the DHL domains. Thus, when respondents searched for online information about the COVID-19 vaccines and related topics, most respondents found it to be easy to apply the online information in daily life, and used the online search results to make health-related decisions. This was ultimately associated with positive intentions toward vaccination. While developing vaccine-related information for online health communication strategies, key messages should be credible and relevant. Furthermore, the competency of people to determine the relevance and applicability to improve their health has an impact on the vaccination intention. Improving health literacy in the population and providing credible, timely, relevant information could enhance vaccination uptake in the community.

Strength and limitations

To the best of our knowledge, this is the first to investigate the association between DHL and intention to vaccinate across 53 countries, with a focus on 11 countries in this paper. This study provides the current insight on vaccination intention across international context and highlighted the importance of DHL. Moreover, competency on determining relevance of information subscale in DHL was found to be particularly important for the willingness to take the vaccination.

Despite the strengths, our study has limitations. Since the non-probability method was used for recruitment, selection bias limits the generalizability of the findings. The nature of the cross-sectional study was to observe for a period of time;

therefore, changes in vaccination intention and availability of vaccines could not be assessed. Approximately two-thirds of our respondents had tertiary education levels and reported living in an urban community, so the generalizability of the findings to other demographics such as rural populations and those of lower education level is uncertain. Considering that the level of digital health literacy is closely related to the internet penetration rate, level of economic development, reaching vulnerable individuals such as older adults, oversampling, and undersampling in some countries, the research results cannot represent the overall general adult population. Therefore, additional large-scale studies and a more systematic, inclusive sampling method are warranted to improve the representativeness and generalizability of the findings.

Conclusion

This study provides an insight into the importance of DHL on the vaccination intention. The respondents generally have sufficient DHL competency. Among them, demographic factors, such as country, residence area, education, employment, and income were associated with the intention for vaccination. Higher competency in assessing the relevance of online information resulted in significantly higher intention for vaccine uptake. In terms of future perspective, not only for COVID-19 but also for the other vaccines, health promotion should be proactive in sharing relevant, timely and applicable information with the community. Priority should be given to improving DHL and vaccination awareness programs targeting lower education level, lower income, and unemployed groups.

Data availability statement

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

Ethics statement

The studies involving human participants were reviewed and approved by Asia Metropolitan University Ethics Committee in Malaysia (Ref. No: AMU/MREC/NF/18022021). The patients/participants provided their written informed consent to participate in this study.

Author contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas, took part in drafting, revising or critically reviewing the article, gave final approval of the version to be published, have agreed on the journal to which the article has been submitted, and agree to be accountable for all aspects of the work.

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Conflict of interest

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

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpubh.2022.998234/full#supplementary-material

References

1. OECD. *The Territorial Impact of COVID-19: Managing the Crisis Across Levels of Government.* (2020). Available online at: https://www.oecd.org/coronavirus/policy-responses/the-territorial-impact-of-covid-19-managing-the-crisis-across-levels-of-government-d3e314e1/ (accessed July 10, 2022).

2. Marzo RR, Khanal P, Ahmad A, Rathore FA, Chauhan S, Singh A, et al. Quality of life of the elderly during the COVID-19 pandemic in Asian countries: a cross-sectional study across six countries. *Life.* (2022) 12:365. doi: 10.3390/life12030365

3. RilleraMarzo R, Villanueva EQ, Chandra U, Htay MNN, Shrestha R, Shrestha S. Risk perception, mental health impacts and coping strategies during Covid-19 pandemic among Filipino healthcare workers. *J Public Health Res.* (2021) 10:jphr.2021.2604. doi: 10.4081/jphr.2021.2604

4. Marzo RR, Vinay V, Bahari R, Chauhan S, Ming DAF, Fernandez SFAN, et al. Depression and anxiety in Malaysian population during third wave of the COVID-19 pandemic. *Clin Epidemiol Global Health.* (2021) 12:100868. doi: 10.1016/j.cegh.2021.100868

5. Htay MNN, Marzo RR, Bahari R, AlRifai A, Kamberi F, El-Abasiri RA, et al. How healthcare workers are coping with mental health challenges during COVID-19 pandemic? A cross-sectional multi-countries study. *Clin Epidemiol Global Health.* (2021) 11:100759. doi: 10.1016/j.cegh.2021.100759

6. Htay MNN, Marzo RR, AlRifai A, Kamberi F, El-Abasiri RA, Nyamache JM, et al. Immediate impact of COVID-19 on mental health and its associated factors among healthcare workers: a global perspective across 31 countries. *J Glob Health.* 10:020381. doi: 10.7189/jogh.10.020381

7. Kamberi F, Sinaj E, Jaho J, Subashi B, Sinanaj G, Jaupaj K, et al. Impact of COVID-19 pandemic on mental health, risk perception and coping strategies among health care workers in Albania - evidence that needs attention. *Clin Epidemiol Global Health.* (2021) 12:100824. doi: 10.1016/j.cegh.2021.100824

8. Marzo RR, Aye SS, Naing TW, Kyaw TM, Win MT, Soe HHK, et al. Factors associated with psychological distress among Myanmar residents during COVID-19 pandemic crises. *J Public Health Res.* (2021) 10:jphr-2021. doi: 10.4081/jphr.2021.2279

9. Marzo RR, Ismail Z, Htay MNN, Bahari R, Ismail R, Villanueva III EQ, et al. Psychological distress during pandemic Covid-19 among adult general population: Result across 13 countries. *Clin Epidemiol Global Health.* (2021) 10:100708. doi: 10.1016/j.cegh.2021.100708

10. Marzo RR, Singh A, Mukti RF. A survey of psychological distress among Bangladeshi people during the COVID-19 pandemic. *Clin Epidemiol Global Health.* (2021) 10:100693. doi: 10.1016/j.cegh.2020.100693

11. Abasiri RAE, RilleraMarzo R, Abdelaziz H, SherifBoraii, Abdelaziz H. Evaluating the psychological distress of the coronavirus disease 2019 Pandemic in Egypt. *Eur J Mol Clin Med.* (2020) 7:1–12.

12. Marzo RR, Villanueva III EQ, Faller EM, Baldonado AM. Factors associated with psychological distress among Filipinos during coronavirus disease-19 pandemic crisis. *Open Access Maced J Med Sci.* (2020) 8:309–13. doi: 10.3889/oamjms.2020.5146

13. Respati T, Irasanti SN, Sartika D, Akbar IB, Marzo RR, A. nationwide survey of psychological distress among Indonesian residents during the COVID-19 pandemic. *Int J Public Health Science.* (2021) 10:119–26. doi: 10.11591/ijphs.v10i1.20609

14. Galvani A, Moghadas S, Schneider E. *Deaths & Hospitalizations Averted by Rapid US Vaccination Rollout | Commonwealth Fund.* The Commonwealth Fund (2021). Available online at: https://www.commonwealthfund.org/publications/issue-briefs/2021/jul/deaths-and-hospitalizations-averted-rapid-us-vaccination-rollout (accessed July 10, 2022).

15. Johnson AG. COVID-19 incidence and death rates among unvaccinated and fully vaccinated adults with and without booster doses during periods of delta and omicron variant emergence — 25 U.S. Jurisdictions, April 4–December 25, 2021. *MMWR Morb Mortal Wkly Rep.* (2022) 71:132–8. doi: 10.15585/mmwr.mm7104e2

16. Marzo RR, Ahmad A, Islam MS, Essar MY, Heidler P, King I, et al. Perceived COVID-19 vaccine effectiveness, acceptance, and drivers of vaccination decision-making among the general adult population: a global survey of 20 countries. *PLoS Negl Trop Dis.* (2022) 16:e0010103. doi: 10.1371/journal.pntd.0010103

17. Marzo RR, Sami W, Alam MdZ, Acharya S, Jermsittiparsert K, Songwathana K, et al. Hesitancy in COVID-19 vaccine uptake and its associated factors among the general adult population: a cross-sectional study in six Southeast Asian countries. *Trop Med Health.* (2022) 50:4. doi: 10.1186/s41182-021-00393-1

18. Elsayed M, El-Abasiri RA, Dardeer KT, Kamal MA, Htay MNN, Abler B, et al. Factors influencing decision making regarding the acceptance of the COVID-19

vaccination in Egypt: a cross-sectional study in an urban, well-educated sample. *Vaccines.* (2022) 10:20. doi: 10.3390/vaccines10010020

19. Marzo RR, Ahmad A, Abid K, Khatiwada AP, Ahmed A, Kyaw TM, et al. Factors influencing the acceptability of COVID-19 vaccination: a cross-sectional study from Malaysia. *Vacunas.* (2022) 23:S33–40. doi: 10.1016/j.vacun.2021.07.007

20. King I, Heidler P, Marzo RR. The long and winding road: uptake, acceptability, and potential influencing factors of COVID-19 vaccination in Austria. *Vaccines.* (2021) 9:790. doi: 10.3390/vaccines9070790

21. Cascini F, Pantovic A, Al-Ajlouni YA, Failla G, Puleo V, Melnyk A, et al. Social media and attitudes towards a COVID-19 vaccination: a systematic review of the literature. *EClinicalMedicine.* (2022) 48:101454. doi: 10.1016/j.eclinm.2022.101454

22. Amo-Adjei J, Nurzhynska A, Essuman R, Lohiniva AL. Trust and willingness towards COVID-19 vaccine uptake: a mixed-method study in Ghana, 2021. *Arch Public Health.* (2022) 80:1–12. doi: 10.1186/s13690-022-00827-0

23. Asia Society Policy Institute. *Southeast Asia and COVID-19 Misinformation - Asia Society Policy Institute.* Australia: Asia Society Policy Institute (2021). Available online at: https://southeastasiacovid.asiasociety.org/southeast-asia-and-covid-19-misinformation/ (accessed July 10, 2022).

24. El Otmani Dehbi Z, Sedrati H, Chaqsare S, Idrissi Azami A, Merzouki M, Raji M, et al. Moroccan digital health response to the COVID-19 crisis. *Front Public Health.* (2021) 9:690462. doi: 10.3389/fpubh.2021.690462

25. Odone A, Gianfredi V, Sorbello S, Capraro M, Frascella B, Vigezzi GP, et al. The use of digital technologies to support vaccination programmes in Europe: state of the art and best practices from experts' interviews. *Vaccines.* (2021) 9:1126. doi: 10.3390/vaccines9101126

26. Kat J. Digital health tools can help with COVID-19 vaccine hesitancy. Healthcare IT News. (2021). Available online at: https://www.healthcareitnews.com/news/digital-health-tools-can-help-covid-19-vaccine-hesitancy (accessed August 14, 2022).

27. Levin-Zamir D, Bertschi I. Media health literacy, eHealth literacy, and the role of the social environment in context. *Int J Environ Res Public Health.* (2018) 15:1643. doi: 10.3390/ijerph15081643

28. The Wellness Network. *Digital Health Literacy Key Component to Improved Health Outcomes.* The Wellness Network (2020). Available online at: https://www.thewellnessnetwork.net/health-news-and-insights/blog/digital-health-literacy/ (accessed July 10, 2022).

29. World Health Organization. *Regional Office for Europe. Survey Tool and Guidance: Rapid, Simple, Flexible Behavioural Insights on COVID-19.* (2020). Report No.: WHO/EURO:2020-696-40431-54222. Available online at: https://apps.who.int/iris/handle/10665/333549 (accessed August 14, 2022).

30. Taber KS. The Use of Cronbach's alpha when developing and reporting research instruments in science education. *Res Sci Educ.* (2018) 48:1273–96. doi: 10.1007/s11165-016-9602-2

31. Patil U, Kostareva U, Hadley M, Manganello JA, Okan O, Dadaczynski K, et al. Health literacy, digital health literacy, and COVID-19 pandemic attitudes and behaviors in US college students: implications for interventions. *Int J Environ Res Public Health.* (2021) 18:3301. doi: 10.3390/ijerph18063301

32. Dadaczynski K, Okan O, Messer M, Leung AY, Rosário R, Darlington E, et al. Digital health literacy and web-based information-seeking behaviors of university students in Germany during the COVID-19 pandemic: cross-sectional survey study. *J Med Internet Res.* (2021) 23:e24097. doi: 10.2196/24097

33. Zakar R, Iqbal S, Zakar MZ, Fischer F. COVID-19 and health information seeking behavior: digital health literacy survey amongst university students in Pakistan. *Int J Environ Res Public Health.* (2021) 18:4009. doi: 10.3390/ijerph18084009

34. Htay MNN, Parial LL, Tolabing MC, Dadaczynski K, Okan O, Leung AYM, et al. Digital health literacy, online information-seeking behaviour, and satisfaction of Covid-19 information among the university students of East and South-East Asia. *PLoS ONE.* (2022) 17:e0266276. doi: 10.1371/journal.pone.0266276

35. Rasekaba TM, Pereira P, Rani GV, Johnson R, McKechnie R, Blackberry I. Exploring telehealth readiness in a resource limited setting: digital and health literacy among older people in Rural India (DAHLIA). *Geriatrics.* (2022) 7:28. doi: 10.3390/geriatrics7020028

36. Shepherd J. "What is the digital era?" In: Social and economic transformation in the digital era. *IGI Global.* (2004) 1–18. doi: 10.4018/978-1-59140-158-2.ch001

37. Okan O, Messer M, Levin-Zamir D, Paakkari L, Sørensen K. Health literacy as a social vaccine in the COVID-19 pandemic. *Health Promot Int.* (2022) daab197. doi: 10.1093/heapro/daab197

38. WHO. *172 Countries and Multiple Candidate Vaccines Engaged in COVID-19 Vaccine Global Access Facility.* (2020). Available online at: https://www.who.int/news/item/24-08-2020-172-countries-and-multiple-candidate-vaccines-engaged-in-covid-19-vaccine-global-access-facility (accessed July 10, 2022).

39. Solís Arce JS, Warren SS, Meriggi NF, Scacco A, McMurry N, Voors M, et al. COVID-19 vaccine acceptance and hesitancy in low-and middle-income countries. *Nat Med.* (2021) 27:1385–94. doi: 10.1101/2021.03.11.21253419

40. Chaudhuri K, Chakrabarti A, Chandan JS, Bandyopadhyay S. COVID-19 vaccine hesitancy in the UK: a longitudinal household cross-sectional study. *BMC Public Health.* (2022) 22:104. doi: 10.1186/s12889-021-12472-3

41. Malik AA, McFadden SM, Elharake J, Omer SB. Determinants of COVID-19 vaccine acceptance in the US. *EClinicalMedicine.* (2020) 26:100495. doi: 10.1016/j.eclinm.2020.100495

42. Tang X, Gelband H, Nagelkerke N, Bogoch II, Brown P, Morawski E, et al. COVID-19 vaccination intention during early vaccine rollout in Canada: a nationwide online survey. *Lancet Regional Health-Americas.* (2021) 2:100055. doi: 10.1016/j.lana.2021.100055

43. Bari MS, Hossain MJ, Ahmmed F, Sarker MMR, Khandokar L, Chaithy AP, et al. Knowledge, perception, and willingness towards immunization among Bangladeshi population during COVID-19 vaccine rolling period. *Vaccines.* (2021) 9:1449. doi: 10.3390/vaccines9121449

44. Banik R, Islam M, Pranta MUR, Rahman QM, Rahman M, Pardhan S, et al. Understanding the determinants of COVID-19 vaccination intention and willingness to pay: findings from a population-based survey in Bangladesh. *BMC Infect Dis.* (2021) 21:1–15. doi: 10.1186/s12879-021-06406-y

45. Nery N, Jr., Ticona JPA, Cardoso CW, Prates APPB, Vieira HCA, Salvador de Almeida A, et al. COVID-19 vaccine hesitancy and associated factors according to sex: a population-based survey in Salvador, Brazil. *PLoS ONE.* (2022) 17:e0262649. doi: 10.1371/journal.pone.0262649

46. Gramacho WG, Turgeon M. When politics collides with public health: COVID-19 vaccine country of origin and vaccination acceptance in Brazil. *Vaccine.* (2021) 39:2608–12. doi: 10.1016/j.vaccine.2021.03.080

47. MacDonald NE. Vaccine hesitancy: definition, scope and determinants. *Vaccine.* (2015) 33:4161–4. doi: 10.1016/j.vaccine.2015.04.036

48. Government of Canada SC. *COVID-19 Vaccine Willingness Among Canadian Population Groups.* (2021). Available online at: https://www150.statcan.gc.ca/n1/pub/45-28-0001/2021001/article/00011-eng.htm (accessed August 14, 2022).

49. MacDonald N, Dube E, Graham J. *How Government Policies and Political Ideologies Impact Vaccine Acceptance: COVID-19 and Beyond.* The Canadian Vaccination Evidence Resource and Exchange Centre (2021). p. E381–3. Available online at: http://www.cmaj.ca/lookup/doi/10.1503/cmaj.210112 (accessed August 14, 2022).

50. WHO. *UNICEF and WHO Warn of Perfect Storm of Conditions for Measles Outbreaks, Affecting Children.* (2022). Available online at: https://www.who.int/news/item/27-04-2022-unicef-and-who-warn-of--perfect-storm--of-conditions-for-measles-outbreaks--affecting-children (accessed July 10, 2022).

51. Humer E, Jesser A, Plener PL, Probst T, Pieh C. Education level and COVID-19 vaccination willingness in adolescents. *Eur Child Adoles Psychiatry.* (2021) 1–3. doi: 10.1007/s00787-021-01878-4

52. Zychlinsky Scharff A, Paulsen M, Schaefer P, Tanisik F, Sugianto RI, Stanislawski N, et al. Students' age and parental level of education influence COVID-19 vaccination hesitancy. *Eur J Pediatr.* (2022) 181:1757–62. doi: 10.1007/s00431-021-04343-1

53. Ehde DM, Roberts MK, Herring TE, Alschuler KN. Willingness to obtain COVID-19 vaccination in adults with multiple sclerosis in the United States. *Mult Scler Relat Disord.* (2021) 49:102788. doi: 10.1016/j.msard.2021.102788

54. Williams L, Flowers P, McLeod J, Young D, Rollins L, Team CP. Social patterning and stability of intention to accept a COVID-19 vaccine in Scotland: will those most at risk accept a vaccine? *Vaccines.* (2021) 9:17. doi: 10.3390/vaccines9010017

55. Brackstone K, Atengble K, Head M, Boateng L. *Examining Drivers of COVID-19 Vaccine Hesitancy in Ghana: The Roles of Political Allegiance, Misinformation Beliefs, and Sociodemographic Factors.* (2022). Available online at: https://www.medrxiv.org/content/10.1101/2022.03.16.22272463v1 (accessed July 9, 2022).

56. Hossian M, Khan MAS, Nazir A, Nabi MH, Hasan M, Maliha R, et al. Factors affecting intention to take COVID-19 vaccine among Pakistani University Students. *PLoS ONE.* (2022) 17:e0262305. doi: 10.1371/journal.pone.0262305

57. Head KJ, Kasting ML, Sturm LA, Hartsock JA, Zimet GD. A national survey assessing SARS-CoV-2 vaccination intentions: implications for future public health communication efforts. *Sci Commun.* (2020) 42:698–723. doi: 10.1177/1075547020960463

58. Mohamed NA, Solehan HM, Mohd Rani MD, Ithnin M, Che Isahak CI. Knowledge, acceptance and perception on COVID-19 vaccine among Malaysians: a web-based survey. *PLoS ONE.* (2021) 16:e0256110. doi: 10.1371/journal.pone.0256110

59. Piltch-Loeb R, Savoia E, Goldberg B, Hughes B, Verhey T, Kayyem J, et al. Examining the effect of information channel on COVID-19 vaccine acceptance. *PLoS ONE.* (2021) 16:e0251095. doi: 10.1371/journal.pone.0251095

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Perception towards vaccine effectiveness in controlling COVID-19 spread in rural and urban communities: A global survey

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Introduction: Several studies exhibited varying reports of perception toward vaccine effectiveness, vaccine hesitancy, and acceptance of COVID-19 vaccines. As this fluctuated with evidence generation, this study explored the perception toward vaccine effectiveness in rural and urban communities among various countries.

Methods: A cross-sectional study was conducted online from April to August 2021 using convenience sampling among people from different countries approved by the Asia Metropolitan University Medical Research and Ethics. We adapted the questionnaire from the World Health Organization's (WHO) survey tool and guidance on COVID-19. The logistic regression models were performed to show perception toward vaccine effectiveness.

Results: A total of 5,673 participants responded to the online survey. Overall, 64% of participants agreed that the vaccine effectively controlled viral spread, and 23% agreed that there was no need for vaccination if others were vaccinated. Males had 14% higher odds of believing that there was no need for vaccination. Less social media users had 39% higher odds of developing the belief that there is no need for vaccination than all other people vaccinated.

Conclusion: People's perceptions toward vaccine acceptance have fluctuated with the information flow in various social media and the severity of COVID-19 cases. Therefore, it is important that the current scenario of peoples' perception toward vaccine acceptance and determinants affecting the acceptance are explored to promote the vaccination approach against COVID-19 prevention and transmission effectively.

Introduction

The spread of coronavirus disease 2019 (COVID-19) has affected the worldwide (1–3). Although vaccines may not fully protect from the COVID-19, it is one of the most important public health interventions as the full range of vaccination among community people can help protect from transmission of infection from the infected to the uninfected and control potential death (4–9). While herd immunity achieved with vaccination is a potential public health intervention against COVID-19, vaccine hesitancy (i.e., reluctance in vaccine acceptance or even delays in refusal amidst the availability of safety- and effectiveness-assured vaccination facilities) has become a global public health concern (4–10). COVID-19 vaccine acceptance or hesitancy, like in the case of other vaccines, is context-specific, varying across the country, time, and place (8) due to socio-demographic differences, health conditions, individual cognitive, psychological and behavioral factors, awareness about vaccines' safety, effectiveness and potential side effects, fast development compared to other vaccines, perceived lack of testing, control of myths, confidence in the health system, and political and cultural factors. Since vaccine hesitancy plays a significant barrier to successful vaccination campaigns, the availability of COVID-19 vaccines does not solve the issue (4, 7, 11–13). Also, Covid vaccine hesitancy reflected an interesting public perception that it rose significantly when new and deadly variants emerged (14). Hence, health workers and policymakers should address the root cause of hesitancy to successfully make the global vaccine action plan (11, 13). The SAGE Working Group on Vaccine Hesitancy concluded that vaccine hesitancy refers to "*delay in acceptance or refusal of vaccination despite availability of vaccination services. Vaccine hesitancy is complex and context-specific, varying across time, place, and vaccines.*" Vaccine hesitancy is influenced by factors such as complacency, convenience, and confidence (15). Vaccine hesitancy is usually guided by three major factors: individuals' perception toward all vaccination programs, including COVID-19 vaccine peers' influence, and perceived behavioral control (7).

Some people may initially show hesitancy due to less awareness about vaccination, cost implications, and poor or substandard health literacy, but later may be interested after

they become aware of the long-term safety data with vaccination [13, 16]. A case in point was that 91% were willing to get the COVID vaccine in Ecuador, if it is at least 95% effective [17]. Vaccine hesitancy is especially problematic for individuals with chronic diseases, disabilities, those requiring long-term care facilities, and geriatric patients [18]. The anti-vax groups' conspiracy theories, misperceptions, and expert opinions on the consequences of the COVID-19 vaccine are also fueling hesitancy [16]. In India, a massive mass of target users usually shows vaccine hesitancy even for routine immunization, which was reflected in the hesitancy to measles-rubella vaccine in 2016 [5], which was previously reported in the USA [16]. Different studies have exhibited varying reports of hesitancy and acceptance of COVID-19 vaccines [9, 19, 20]. As this fluctuated with evidence generation, this study explored the perception toward vaccine effectiveness in rural and urban communities among various countries. The study findings would help the policymakers and practitioners become aware of the latest trends and determinants in the success of vaccination and devise efficient and effective strategies for the same.

Methods

Study design and sampling

A cross-sectional online survey was conducted online from April to August 2021 using convenience sampling among people from five different countries. Bangladesh, Iran, Malaysia, Philippines, and Turkey were selected for the study based on investigation resources within our existing international research group and high disease burden of COVID-19. The sample sizes for each country were calculated $n = 384$ according to sample size calculation using 95% CI, 50% response, and 0.05 margin of error [21]. The study was conducted using convenience sampling *via* web-based online method. According to Stratton, the convenience sampling participants are available around a location, Internet site, or customer-membership list. It is an acknowledged form of sampling and is often found in population research and disaster research [22]. The questionnaires were shared to be filled by participants from April to August 2021. The response received during that period was cleared and taken into analysis.

Ethics approval

The study was approved by the Asia Metropolitan University Medical Research and Ethics (Ref. AMU FOM 0400132021).

Instrument development and measures

The questionnaire was adapted from the World Health Organization's (WHO) survey tool and guidance on COVID-19

[23]. All participants were informed about the survey's purpose and provided their informed consent before participation. Participants were ensured of the confidentiality and privacy of their responses to reduce potential bias introduced by self-reported data. The participants could only complete the questionnaires once, and the Google form was set to receive anonymous responses without identifying emails or contact details. The questionnaire was structured into two sections: (1) socio-demographic characteristics and medical history and (2) perception of COVID-19 vaccine effectiveness.

The questionnaire was initially developed in English and translated into local languages. Then, the research team back-translated, pre-tested, and revised the questionnaire in the selected five countries. A group of expert panels in the respective countries included psychiatrists, clinical psychologists, physicians, and public health experts translated and culturally validated into their national. Pilot testing comprised 15 participants in each country to test face validity and 50 participants in each country to test the internal consistency. The Cronbach's alpha value ranging from 0.86 to 0.97 indicated that the questionnaire has good internal consistency across all countries. It took approximately 8–10 mins to complete the survey.

Data collection

As the researchers worldwide utilized social media platforms to collect data amid the global pandemic, a Google form survey link was distributed to online social media platforms (Facebook and WhatsApp) to recruit participants in this study. Participants were requested to pass on the questionnaire to their contacts or acquaintances in a pattern of snowball sampling. The outcomes of the study were, on each occasion, whether people believed or not: (1) in the effectiveness of the vaccine against COVID-19; (2) there is no need for vaccination for the post-infected individuals; and (3) there is no need for vaccination when all others are already vaccinated.

Socio-demographic characteristics and medical history

The socio-demographic characteristics of the participants collected were age, gender, religion, education, marital status, smoking, residence, employment status, and income level. Besides, the use of social media, satisfaction with online information related to COVID-19 and vaccines, the experience of online searching COVID-19 and vaccine information, websites surfed, and trusted online information were also explored *via* Google form. In addition, participants were asked to report their medical history related to chronic conditions and

the extent of health impairment. All of these were considered the predictor variables.

Outcome variables

The outcome of the study was to understand the perception toward vaccine effectiveness to COVID-19 vaccination. To measure this, three questions were developed as outcome variables that were whether people agreed or not: (1) vaccine can control the viral spread; (2) post-COVID-19 patients must take the vaccine; and (3) there is no need for vaccination when the total population is vaccinated.

Statistical analysis

Logistic regression models were performed to show the predictors for perception toward vaccine effectiveness. The adjusted odds ratio (AOR) was used to nullify the effects of the potential confounders. The variables were selected using the backward method depending on an extensive literature search and the principle of parsimony in selecting potential predictors. Relevant assumptions were made to ensure the goodness of fit of each model, the absence of any multi-collinearity, and the homogeneity of variance of the residuals.

Results

Demographic information

Table 1 provides the comparative description of participants' demographics based on rural and urban residential sites. A total of 5,673 participants responded to the study, the majority of whom were female (56%), from urban areas (68%), Islam (61%), with tertiary level of education (72%), had full-time employment (38%) and sufficient income (52%), but not suffering from chronic diseases (86%) and health impairments (80%). These variables were reported to differ significantly between rural and urban areas except gender.

Participants' online activities related to COVID-19 and vaccine

Table 2 depicts participants' online activities regarding COVID-19 and vaccine information based on rural and urban sites. The majority of participants did not like to use social media (such as Facebook and YouTube) frequently (86%) but had trust in online information (78%) and mostly surfed the WHO website for COVID-related information (62%). However, this study reported that participants were neutral

on COVID-19 information received through online platforms (33%), using other than the English language for online search (76%), experiencing difficulty in finding COVID-19-related information online (55%), and had not surfed different websites (59%) for the same. The study also determined that most participants had a good relationship with the lower socioeconomic group of people in the community (57%). The majority of the participants confirmed that they could post-effective online posts related to the COVID-19 vaccine, and they may share some private information on themselves or others intentionally or non-intentionally (58%). However, they found it difficult to formulate a question or express their thoughts and feelings about the COVID-19 vaccine (53%).

Participants' residential information

Figure 1 depicts the details of the top five countries of participants. Except for the Philippines and Iran, all three other countries' participants mostly lived in urban areas during data collection.

Participants' response to COVID-19 vaccine

Figure 2 represents the distribution of the three primary outcomes of the study. Overall, 64% of participants agreed that the vaccine effectively controlled viral spread, 26% agreed that there was no need for vaccination for post-COVID-19 patients, and 23% agreed that there was no need for vaccination if others were vaccinated.

Regression analysis between participants' variable and three main responses related to COVID-19 vaccine

Table 3 represents that participants' age, employment status, relationship with the different socioeconomic groups, income, experience of finding information online, surfing different websites, and trust in online information significantly affected their perception of vaccine effectiveness in controlling COVID-19 infection. Controlling all other variables, the study found that:

- Increasing age by 1 unit decreased the odds of trusting the vaccine's effectiveness by 4%.
- Students and retired participants had very high (2.07 and 1.81) odds of trusting the vaccine's effectiveness compared to all other participants' employment status, respectively.

TABLE 1 Comparative description of participants' demographics according to rural and urban areas.

Characteristics	Overall ($n = 5,673$)	Rural ($n = 1,804$)	Urban ($n = 3,869$)	p-value
Gender				0.062
Female	3,181 (56%)	979 (54%)	2,202 (57%)	
Male	2,492 (44%)	825 (46%)	1,667 (43%)	
Religion				**<0.001**
Buddhism	482 (8.5%)	84 (4.7%)	398 (10%)	
Christianity	1,258 (22%)	667 (37%)	591 (15%)	
Hinduism	316 (5.6%)	10 (0.6%)	306 (7.9%)	
Islam	3,470 (61%)	1,001 (55%)	2,469 (64%)	
Other	147 (2.6%)	42 (2.3%)	105 (2.7%)	
Age [Median(Q1, Q3)]	25 (21, 39)	23 (21, 32)	27 (22, 42)	**<0.001**
Education				**<0.001**
No formal education	53 (0.9%)	24 (1.3%)	29 (0.7%)	
Primary	158 (2.8%)	74 (4.1%)	84 (2.2%)	
Secondary	1,387 (24%)	443 (25%)	944 (24%)	
Tertiary	4,075 (72%)	1,263 (70%)	2,812 (73%)	
Employment				**<0.001**
Employed full time	2,155 (38%)	526 (29%)	1,629 (42%)	
Employed part time	416 (7.3%)	185 (10%)	231 (6.0%)	
Looking for Job	256 (4.5%)	111 (6.2%)	145 (3.7%)	
Other	520 (9.2%)	211 (12%)	309 (8.0%)	
Retired	165 (2.9%)	28 (1.6%)	137 (3.5%)	
Student	906 (16%)	150 (8.3%)	756 (20%)	
Unemployed	1,255 (22%)	593 (33%)	662 (17%)	
Income				**<0.001**
Completely sufficient	894 (16%)	179 (9.9%)	715 (18%)	
Less sufficient	1,103 (19%)	451 (25%)	652 (17%)	
Not sufficient	704 (12%)	290 (16%)	414 (11%)	
Other	50 (0.9%)	30 (1.7%)	20 (0.5%)	
Sufficient	2,922 (52%)	854 (47%)	2,068 (53%)	
Chronic diseases*				**0.008**
No	4,906 (86%)	1,568 (87%)	3,338 (86%)	
Yes	717 (13%)	211 (12%)	506 (13%)	
Health impaired by Chronic disease**				**<0.001**
No	4,553 (80%)	1,259 (70%)	3,294 (85%)	
Yes	801 (14%)	418 (23%)	383 (9.9%)	
Extent of health impairment***				**<0.001**
Moderately impaired	926 (16%)	387 (21%)	539 (14%)	
Not at all	1,823 (32%)	332 (18%)	1,491 (39%)	
Severely impaired	357 (6.3%)	189 (10%)	168 (4.3%)	

*50 patients (0.9%) of participants didn't tell whether they had chronic diseases or not. **319 patients (5.6 %) of participants didn't tell whether they had any health impairment due to this chronic disease or not. ***2,567 patients (45%) of participants didn't answer the question regarding the extent of health impairment.

- A good relationship with the socio-economically stable group has decreased the odds of trusting the vaccine's effectiveness by 32%.
- Sufficiency of income levels of the participants showed 22% lower odds on trust in vaccine effectiveness for controlling the infection.
- Participants' online information search related to COVID-19 exhibited 24% lower trust odds on the vaccine effectiveness.
- Participants who surfed different medical websites for COVID-related information had 35% higher trust odds on the vaccine effectiveness.

TABLE 2 Comparative description of participants' online activity related to COVID-19 and vaccine according to rural and urban areas.

Characteristics	Overall ($n = 5,673$)	Rural ($n = 1,804$)	Urban ($n = 3,869$)	p-value
Using social media				>0.9
Frequent	801 (14%)	256 (14%)	545 (14%)	
Low	4,872 (86%)	1,548 (86%)	3,324 (86%)	
Trust on online information				**<0.001**
No	1,262 (22%)	349 (19%)	913 (24%)	
Yes	4,411 (78%)	1,455 (81%)	2,956 (76%)	
Satisfaction with online information related to COVID-19*				**<0.001**
Dissatisfied	469 (8.3%)	154 (8.5%)	315 (8.1%)	
Neutral	1,860 (33%)	561 (31%)	1,299 (34%)	
Satisfied	1,736 (31%)	610 (34%)	1,126 (29%)	
Very dissatisfied	361 (6.4%)	148 (8.2%)	213 (5.5%)	
Very satisfied	328 (5.8%)	102 (5.7%)	226 (5.8%)	
Language used in searching information online				**<0.001**
English	1,372 (24%)	557 (31%)	815 (21%)	
Not English	4,301 (76%)	1,247 (69%)	3,054 (79%)	
Experience of searching COVID-19 information online				**<0.001**
Difficult	3,126 (55%)	1,072 (59%)	2,054 (53%)	
Easy	2,547 (45%)	732 (41%)	1,815 (47%)	
Surfing different websites for COVID-19 information				0.8
No	3,324 (59%)	1,062 (59%)	2,262 (58%)	
Yes	2,349 (41%)	742 (41%)	1,607 (42%)	
Surfing WHO website for COVID-19 information				0.4
Frequently	3,543 (62%)	1,142 (63%)	2,401 (62%)	
Rarely	2,130 (38%)	662 (37%)	1,468 (38%)	
Effectiveness of online posting				**0.017**
No	2,369 (42%)	712 (39%)	1,657 (43%)	
Yes	3,304 (58%)	1,092 (61%)	2,212 (57%)	
Ability to effectively express thoughts about vaccine through social media				0.085
No	3,032 (53%)	934 (52%)	2,098 (54%)	
Yes	2,641 (47%)	870 (48%)	1,771 (46%)	
Good relationship with				**<0.001**
Lower socioeconomic group	2,125 (37%)	770 (43%)	1,355 (35%)	
Higher socioeconomic group	3,548 (63%)	1,034 (57%)	2,514 (65%)	

*919 patients (16%) of participants didn't answer the question regarding online information satisfaction.

- Participants' trust in online information regarding COVID and vaccine information had 16% lower odds on trust in the vaccine effectiveness.

Table 4 represents that participants' residential sites, gender, age, frequency of using social media, surfing different websites, including that of the WHO, for COVID-related information, participants' effective online posting, and their ability to express themselves online significantly affected their perception on no requirement of vaccination for post-COVID patients.

Adjusting all other variables' impacts, the study found that:

- Participants residing in urban areas had a 34% higher chance of believing that there was no need for vaccination for post-COVID-19 patients.
- Males had 14% higher odds of believing that there was no need for vaccination.
- Increasing age by 1 unit would decrease the chances of unbelief on vaccination need for post-COVID patients by 1%.
- Less social media app users had 42% higher odds of unbelief in need for vaccination for post-COVID-19 patients.
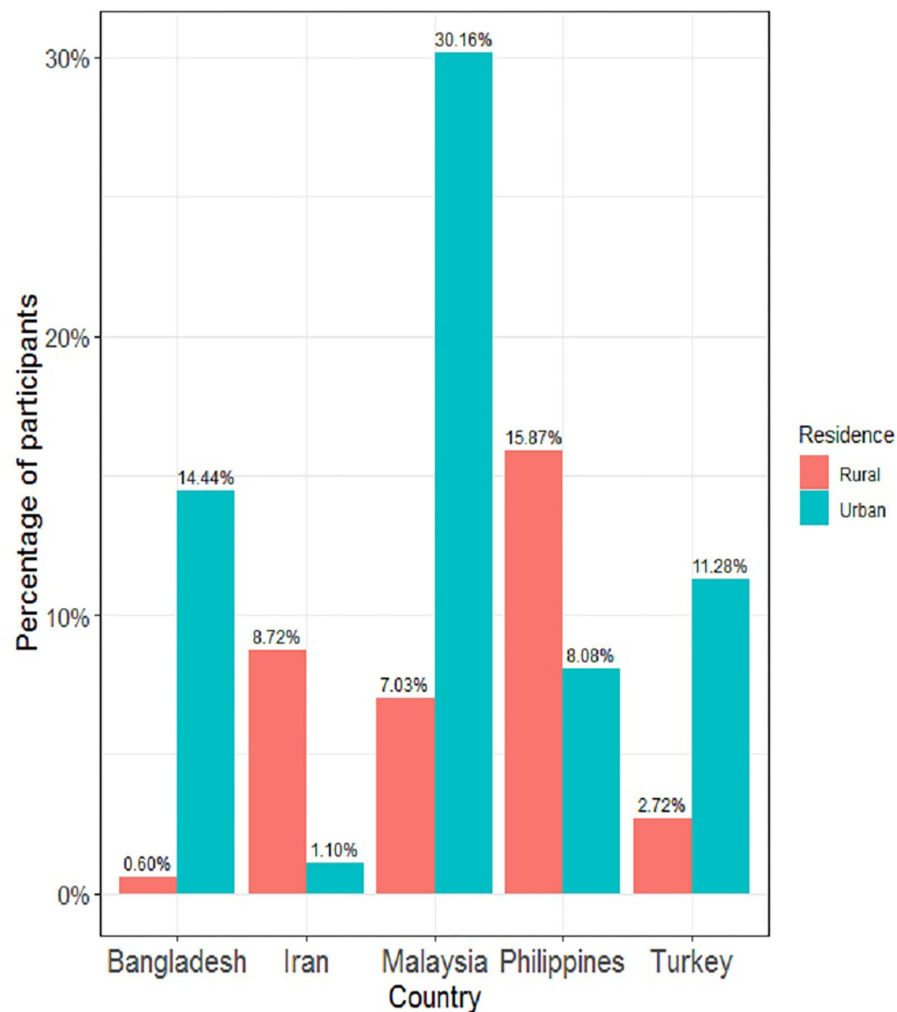
FIGURE 1
Country-wise distribution of participants in rural and urban area.

- Those who could post-effectively on social media had 45% higher odds of unbelief in need for vaccination for post-COVID-19 patients.
- Those who could express their feelings effectively online had 18% higher odds of unbelief in need for vaccination for post-COVID-19 patients.
- Occasional visitors of the WHO website had 27% lower odds of believing there was no need for vaccination for post-COVID-19 patients.
- Those who surfed different websites for COVID-19 information had 22% higher odds of developing unbelief toward the need for vaccination for post-COVID patients.

Table 5 provides the details of factors such as language, employment, frequency of using social media, surfing WHO websites for COVID-related information, and participants'

effective online posting significantly affected the perception of no vaccination requirement for post-COVID patients. Adjusting all other variables, the study found that:

- Non-English language users had 29% higher odds of believing that they need no vaccination.
- Students, full-time workers, part-time workers, and retired participants had 4.16, 1.01, 1.15, and 1.37 times higher odds of believing they did not need to be vaccinated when all other people got vaccinated.
- Those who could post online effectively had 58% higher odds of developing the belief of no need for vaccination when all other people got vaccinated.
- Less social media users had 39% higher odds of developing the belief in no need for vaccination than all other people who got vaccinated.

FIGURE 2
Participants' response on COVID-19 vaccine.
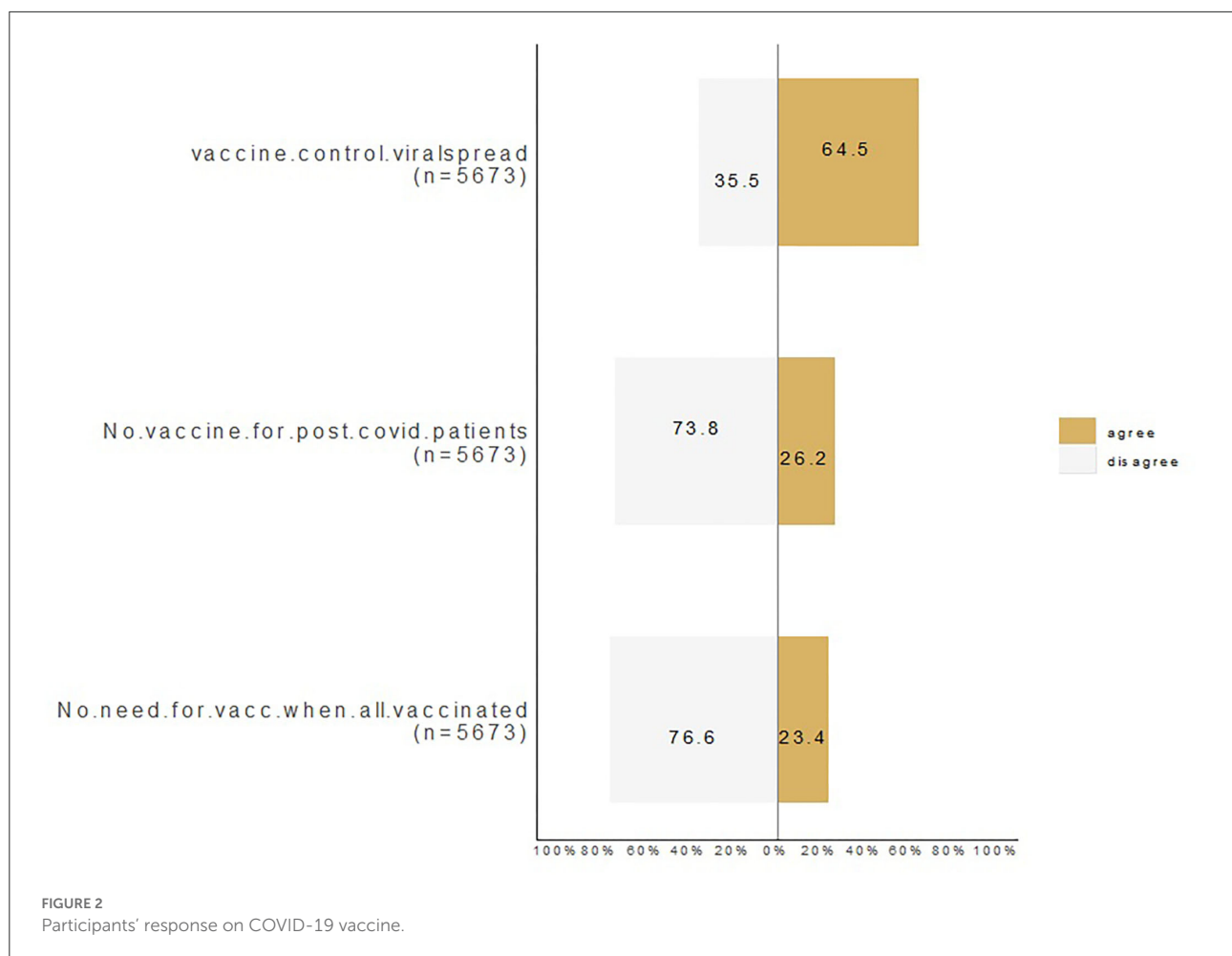
- Occasional visitors of the WHO website showed 32% lower odds of believing that they had not been vaccinated when all other people got vaccinated.

Discussion

The vaccination is the most appropriate approach for preventing and spreading COVID-19. However, peoples' perceptions toward vaccine effectiveness have fluctuated with the information flow on various social media channels and the severity of COVID cases (24, 25). Therefore, it is important that the current scenario of peoples' perception toward vaccine effectiveness and determinants affecting the same be explored to promote the vaccination approach against COVID-19 prevention and transmission effectively. This multinational study, highly representing the Asian countries, determined that nearly two-thirds of the public perceived the vaccine's effectiveness positively; however, nearly one in four people perceived that vaccination was not needed for post-COVID patients and that others were vaccinated. Haque et al. (6)

reported that people with chronic diseases were less interested in vaccination in Bangladesh. The acceptance rate was higher among adults aged 30 years and above and among high-income groups (6). A systematic review carried out by Cascini et al. analyzed different countries' vaccine hesitancy profiles and found a fluctuating pattern of vaccine hesitancy, with an initial decrease followed by increased rates (4).

Perception toward vaccine effectiveness in controlling COVID-19 spread

This large-scale multinational survey determined that more than half (64%) of participants agreed that vaccines effectively controlled COVID spread. Similarly, high vaccine acceptance was previously seen in the study of the United States (78%, 1,878 samples) conducted in June 2020, six sub-Saharan African countries (82.55%, 11,895 samples) conducted from October to December 2020, and a global survey encompassing 17 countries in the American, European, and Asian regions (90.4%, 19,714

TABLE 3 Factors affecting the participants' agreement of vaccine effectiveness in controlling COVID-19 infection.

Characteristics	AOR (95% CI)	*p*-value
Age (in years)	0.96 (0.95–0.97)	**<0.001**
Employment		
Unemployed	—	
Employed (Full time)	1.29 (1.09–1.54)	**0.004**
Employed (Part time)	1.46 (1.15–1.86)	**0.002**
Searching for employment	1.11 (0.83–1.48)	0.5
Other	0.94 (0.75–1.17)	0.6
Retired	1.81 (1.11–2.90)	**0.014**
Student	2.07 (1.72–2.49)	**<0.001**
Good relationship with		
Lower socioeconomic group	—	
Higher socioeconomic group	0.68 (0.60–0.77)	**<0.001**
Income level		
Not sufficient	—	
Completely sufficient	1.09 (0.87–1.37)	0.5
Less sufficient	0.88 (0.72–1.09)	0.2
Other	1.19 (0.65–2.18)	0.6
Sufficient	0.78 (0.64–0.94)	**0.010**
Experience of searching COVID-19 information online		
Difficult	—	
Easy	0.76 (0.67–0.86)	**<0.001**
Surfing different websites for COVID-19 information		
No	—	
Yes	1.35 (1.18–1.53)	**<0.001**
Trust on online information		
No	—	
Yes	0.84 (0.72–0.99)	**0.040**

AOR, Adjusted odds ratio; CI, Confidence interval.

TABLE 4 Factors affecting the participants' agreement on no vaccination to post-COVID patients.

Characteristics	AOR (95% CI)	*p*-value
Residence		
Rural		
Urban	1.34 (1.18–1.53)	**<0.001**
Gender		
Female		
Male	1.14 (1.01–1.29)	**0.041**
Age (in years)	0.99 (0.99–1.00)	**0.019**
Using social media		
Frequent		
Low	1.42 (1.18–1.71)	**<0.001**
Effectiveness of online posting		
No		
Yes	1.45 (1.29–1.66)	**<0.001**
Ability to effectively express thoughts through social media		
No		
Yes	1.18 (1.02–1.35)	**0.022**
Surfing different websites for COVID-19 information		
No		
Yes	1.22 (1.03–1.44)	**0.018**
Surfing WHO websites for COVID-19 information		
Frequently		
Rarely	0.73 (0.62–0.86)	**<0.001**

AOR, Adjusted odds ratio; CI, Confidence interval.

samples) conducted in January to March 2021 (15, 25). The lower increment in vaccine hesitancy can be attributed to the attempt of countries on the strict vaccination campaigns with the certification before traveling and working globally, and the most appropriate reason experienced by the public was the absence of any other preventive alternatives over vaccines at the later phase. However, compared to similar studies, this study reported relatively higher hesitancy (15, 26, 27).

Aligning with our finding, the recent study conducted in Ethiopia showed hesitancy of vaccination by only half of the participants. Hence, it shows an incline trend to vaccine hesitancy over the period of time, so the appropriate awareness regarding vaccine effectiveness needs to be immediately provided. Further exploration determined that those who searched different websites for vaccine information, and students, retired, and working personnel had a higher positive perception of vaccine effectiveness. Vaccination has been made as a preliminary step for every public movement, work,

and different activities that probably have encouraged people to accept it. However, increases in age, good relationships with higher socioeconomic groups, people having ease in finding vaccine-related information, and higher trust in online information had low odd value (<1) on vaccine effectiveness perception. This probably could reflect the trust of the elderly in biased, inappropriate, and fake information available on online platforms. In fact, the recent study also confirmed that people's vaccine acceptance or hesitancy was highly influenced by the information distributed in social media (24, 28).

Overall, it is clearly confirmed that public generally look social media and website for obtaining the true information, they need and get influenced by the information shared there. Hence, the concerned healthcare awareness organization and government should monitor and control to pass the genuine knowledge to public and change their perception and behavior accordingly. Similar to our finding, a recent review on determinants of COVID-19 vaccines in low- and middle-income countries (LMICs) also reported that occupation (specifically healthcare worker) and higher education had lower hesitancy of COVID-19 vaccines (29). Furthermore, recent reviews emphasized that improper awareness of public trust in vaccine effectiveness was the typical determinant of vaccine

Factors affecting the participants' agreement on no need of vaccination in case others got vaccinated.

Characteristics	AOR (95% CI)	*p*-value
Language used in searching information online		
English		
Not English	1.29 (1.10–1.51)	**0.002**
Employment		
Unemployed		
Employed (Full-time)	1.01 (0.86–1.19)	>0.9
Employed (Part-time)	1.15 (0.89–1.51)	0.3
Searching for employment	0.67 (0.50–0.90)	**0.007**
Other	0.75 (0.60–0.94)	**0.014**
Retired	1.37 (0.93–2.06)	0.12
Student	4.16 (3.11–5.64)	**<0.001**
Effectiveness of online posting		
No		
Yes	1.58 (1.37–1.82)	**<0.001**
Using social media		
Frequent		
Low	1.39 (1.15–1.68)	**<0.001**
Surfing WHO website for COVID-19 information		
Frequently		
Rarely	0.68 (0.59–0.79)	**<0.001**

AOR, Adjusted odds ratio; CI, Confidence interval.

hesitancy (29). Similarly, previous data of the WHO/UNICEF showed that scientific evidence-based information, awareness, and knowledge, and cultural or socioeconomic parameters were the prominent factors affecting vaccine acceptability (30). In addition, Hassan et al. reported that the belief of COVID infection treatment by traditional method had 37% higher odds to develop vaccine hesitancy (28). On the contrary, social media and online information were reported to have a comparatively very high impact on public perception (31, 32). Therefore, proper orientation of the public toward utilizing the online platform, trustworthy resources for healthcare-related information, and proper dissemination of accurate information through the online portal conveniently are crucial to improve the public perception of current vaccination.

Perception toward the need for vaccination for post-COVID patients

COVID-19 has been transmitted to a wide range of populations and countries. Although the infected participants may have developed immunity against the virus after an infection, timely vaccination has been considered appropriate and promoted (33). Conversely, this study determined that around one-fourth of the public (26%) still perceived no need

for vaccination for post-COVID patients. Similarly, people living in urban places, male, less social media but high website users for COVID-19 information, and those who expressed their opinion effectively online had relatively higher odds of developing a perception of no need for vaccination for post-COVID patients. Participants living in urban places and surfing websites more for COVID information were naturally expected to have lower odds of having inappropriate perception; however, it was not found coherent. This probably has been the consequence of inappropriate availability and accessibility of accurate information related to COVID or the inability of the public to search and differentiate accurate information on COVID. A recent study of Ethiopia reported that people have a perception of further deterioration of their existing medical problem and even an understanding of suffering by COVID infection after COVID vaccination. Hence, the major concern toward the inappropriate perception existed for vaccination is the lack of unbiased information and awareness to the community. Therefore, the concerned authorities of the respective country must take appropriate action to facilitate the proper dissemination of scientific evidence-based information among the public through social media networking and government health-related websites. For instance, awareness campaigns *via* social media posting by the government of Macao were reported to influence significantly through higher patient engagement during the COVID-19 pandemic (34). Similarly, the active engagement of doctors and their recommendation to patient on vaccination have been reported to reduce hesitancy significantly in China (35). The Austrian study from King et al. displayed similar results and showed that doctor's recommendation greatly influences the decision-making process, and tailored vaccine information can support a higher vaccine coverage (36).

Perception toward the need for vaccination if others were vaccinated

Lastly, this study found that more than three-fourths of people perceived no need for vaccination if others were vaccinated. It confirmed that people genuinely do not willing to get vaccinated. They do not have true faith in the safety and efficacy of vaccines, but rather, they were looking for another option of not getting vaccinated themselves. Also, the non-English users, students, and fewer social media users but with practical social media posting abilities had higher odds of having the perception of no need for vaccination in case others were vaccinated. Finding language as an associated factor in enhancing false perceptions toward COVID vaccines was also a prominent health-related error. This finding reflected a requirement to disseminate authentic information on COVID to students through understandable native languages, which

could be non-English. For instance, a study on government social media engagement on Facebook during the COVID-19 pandemic in Macao reported a positive impact in attracting public engagement through the COVID-related information transmission *via* the government's official Facebook page. Interestingly, the personnel surfing the WHO websites for Covid information had an appropriate perception with lower odds (33). In addition, the information needed to be transmitted to attract, convince, and remove the misunderstanding to the listener rather than just sharing the information as a part of fulfilling the duty. People in Nigeria who do not have trust on the government have significantly reported to show higher hesitancy. Therefore, the confidence of the government and the information providing organization or media is another important factors that affected the people having hesitancy to COVID-19 vaccination.

Strength and limitation

This multi-country survey is among a few studies exploring factors that may contribute to COVID-19 vaccine uptake improvement using extensive data collected from populations in countries with different socioeconomic and cultural contexts. However, this study has several limitations. Due to our study's cross-sectional nature, we cannot determine whether the outcome followed exposure or exposure followed exposure. Another limitation is the mode of study. Since we used a web-based self-administration mode of survey, there could be potential bias among the participants in responding to the survey questions. However, due to the restrictions related to the pandemic, this was the best mode currently available. Further studies are warranted to explore the relative importance of various vaccine-related, contextual, and individual or group determinants associated with the hesitancy of the COVID-19 vaccines. Moreover, analyzing the results from the missing 15 countries of the global survey and contrasting the outcomes with countries like Austria, Germany, Egypt, or Nigeria might give a broader insight due to cultural differences, social media usage, and urbanization rate. Given the exceptionally high burden of disease for COVID-19, urgent interventions and policies targeting the identified factors are necessary to decrease hesitancy for a COVID-19 vaccine. Targeting vaccine hesitancy is necessary to establish herd immunity worldwide and normalize life with COVID-19.

Conclusion

This multinational online survey is among a few studies exploring factors that may contribute to the perception toward vaccine effectiveness in controlling COVID-19 spread in rural and urban communities in countries with different socioeconomic and cultural contexts. The vaccine is the most appropriate approach for preventing and spreading COVID-19. The perception toward vaccine effectiveness in controlling COVID-19 was greatly influenced by the social media information and by geography. The participants residing in urban areas had a higher chance of believing that there was no need for vaccination for post-COVID-19 patients.

Thus, governments need to raise awareness campaigns in rural areas. Doctor's recommendation and tailored vaccine information can support a higher vaccine coverage and influences the decision-making process. Individuals who gathered unfiltered information, surfed different websites, and consumed fake news for COVID-19 information generated a higher vaccine hesitancy toward the need for vaccination for post-COVID patients than visitors of the WHO website who had lower odds of believing there was now need for vaccination for post-COVID-19 patients. Society is realizing that social media has been deployed to increase social discord and decrease social cohesion. Fake news can be used to manipulate elections, health and vaccination programs, and lives. Awareness campaigns and policies need to be installed to diminish the damage from social media abuse. To promote vaccine acceptance, as experienced in Macao, the concerned authorities must provide the information in a most appropriate way to prevent confusion and misbelief and increase vaccine acceptance.

Data availability statement

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

Ethics statement

The study was approved by the Asia Metropolitan University Medical Research and Ethics (Ref. AMU FOM 0400132021). The patients/participants provided their written informed consent to participate in this study.

Author contributions

All authors contributed equally.

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Conflict of interest

Publisher's note

References

1. Shrestha R, Shrestha S, Khanal P, Bhuvan KC. Nepal's first case of COVID-19 and public health response. *J Travel Med.* (2021) 27:1–2. doi: 10.3126/nmmj.v2i1.37223

2. Bhandari D, Ozaki A, Suzuki T, Kotera Y, Shrestha S, Horiuchi S, et al. Physical and verbal abuse amid COVID-19: A nationwide cross-sectional survey in Japan. *BMJ Open.* (2022) 12:e054915. doi: 10.1136/bmjopen-2021-054915

3. Khatiwada AP, Maskey S, Shrestha N, Shrestha S, Khanal S, Kc B, et al. Impact of the first phase of COVID-19 pandemic on childhood routine immunisation services in Nepal: a qualitative study on the perspectives of service providers and users. *J Pharm Policy Pract.* (2021) 14:1–10. doi: 10.1186/s40545-021-00366-z

4. Cascini F, Pantovic A, Al-Ajlouni Y, Failla G, Ricciardi W. Attitudes, acceptance and hesitancy among the general population worldwide to receive the COVID-19 vaccines and their contributing factors: A systematic review. *EClinicalMedicine.* (2021) 40:101113. doi: 10.1016/j.eclinm.2021.101113

5. Danabal KGM, Magesh SS, Saravanan S, Gopichandran V. Attitude towards COVID 19 vaccines and vaccine hesitancy in urban and rural communities in Tamil Nadu, India – a community based survey. *BMC Health Serv Res.* (2021) 21:1–10. doi: 10.1186/s12913-021-07037-4

6. Akiful Haque MM, Rahman ML, Hossian M, Matin KF, Nabi MH, Saha S, et al. Acceptance of COVID-19 vaccine and its determinants: evidence from a large sample study in Bangladesh. *Heliyon.* (2021) 7:e07376. doi: 10.1016/j.heliyon.2021.e07376

7. Omar DI, Hani BM. Attitudes and intentions towards COVID-19 vaccines and associated factors among Egyptian adults. *J Infect Public Health.* (2021) 14:1481–8. doi: 10.1016/j.jiph.2021.06.019

8. Orangi S, Pinchoff J, Mwanga D, Abuya T, Hamaluba M, Warimwe G, et al. Assessing the level and determinants of covid-19 vaccine confidence in Kenya. *Vaccines.* (2021) 9:936. doi: 10.3390/vaccines9080936

9. Marzo RR, Ahmadnd A, Islam MS, Essar MY, Heidler P, King I, et al. Perceived COVID-19 vaccine effectiveness, acceptance, and drivers of vaccination decision-making among the general adult population: A global survey of 20 countries. *PLoS Negl Trop Dis.* (2022) 16:e0010103. doi: 10.1371/journal.pntd.0010103

10. Shrestha S, Khatri J, Shakya S, Danekhu K, Khatiwada AP, Sah R, et al. Adverse events related to COVID-19 vaccines: the need to strengthen pharmacovigilance monitoring systems. *Drugs Ther Perspect.* (2021) 37:376–82. doi: 10.1007/s40267-021-00852-z

11. Purnell M, Maxwell T, Hill S, Patel R, Trower J, Wangui L, et al. Exploring COVID-19 vaccine hesitancy at a rural historically black college and university. *J Am Pharm Assoc.* (2022) 62:340–4. doi: 10.1016/j.japh.2021.09.008

12. Rahman M, Hossain A, Sufian A, Anwar N. COVID-19 vaccine demand, hesitancy, and nationalism: A case of protection motivation behavior in Bangladesh. *J Infect Dev Ctries.* (2021) 15:1388–95. doi: 10.3855/jidc.15029

13. Xu Y, Cao Y, Ma Y, Zhao Y, Jiang H, Lu J, et al. COVID-19 vaccination attitudes with neuromyelitis optica spectrum disorders: vaccine hesitancy and coping style. *Front Neurol.* (2021) 12:1354. doi: 10.3389/fneur.2021.717111

14. Kalam MA, Davis TP, Shano S, Uddin MN, Islam MA, Kanwagi R, et al. Exploring the behavioral determinants of COVID-19 vaccine acceptance among an urban population in Bangladesh: Implications for behavior change interventions. *PLoS ONE.* (2021) 16:e0256496. doi: 10.1371/journal.pone.0256496

15. MacDonald NE, Eskola J, Liang X, Chaudhuri M, Dube E, Gellin B, et al. Vaccine hesitancy: Definition, scope and determinants. *Vaccine.* (2015) 33:4161–4. doi: 10.1016/j.vaccine.2015.04.036

16. Khubchandani J, Sharma S, Price JH, Wiblishauser MJ, Sharma M, Webb FJ. COVID-19 vaccination hesitancy in the United States: A rapid national assessment. *J Community Health.* (2021) 46:270–7. doi: 10.1007/s10900-020-00958-x

17. Jaramillo-Monge J, Obimpeh M, Vega B, Acurio D, Boven A, Verhoeven V, et al. COVID-19 vaccine acceptance in Azuay province, ecuador: a cross-sectional online survey. *Vaccines.* (2021) 9:678. doi: 10.3390/vaccines9060678

18. Myers A, Ipsen C, Lissau A. COVID-19 vaccination hesitancy among Americans with disabilities aged 18-65: An exploratory analysis. *Disabil Health J.* (2022) 15:101223. doi: 10.1016/j.dhjo.2021.101223

19. Marzo RR, Ahmad A, Abid K, Khatiwada AP, Ahmed A, Kyaw TM, et al. Factors influencing the acceptability of COVID-19 vaccination: A cross-sectional study from Malaysia. *Vacunas.* (2021) 23:S33–40. doi: 10.1016/j.vacun.2021.07.007

20. Marzo RR, Sami W, Alam MZ, Acharya S, Jermsittiparsert K, Songwathana K, et al. Hesitancy in COVID-19 vaccine uptake and its associated factors among the general adult population: a cross-sectional study in six Southeast Asian countries. *Trop Med Health.* (2022) 50:1–10. doi: 10.1186/s41182-021-00393-1

21. Raosoft. Sample Size Calculator. Available onlien at: http://www.raosoft.com/samplesize.html?nosurvey (accessed August 29, 2022)

22. Stratton SJ. Population Research: Convenience Sampling Strategies. *Prehosp Disaster Med.* (2021) 36:373–4. doi: 10.1017/S1049023X21000649

23. World Health Organization. Survey tool and guidance. (2020) vol. 19. p. 1–42. Available online at: http://www.euro.who.int/pubrequest (accessed August 30, 2022)

24. Ouyang H, Ma X, Wu X. The prevalence and determinants of COVID-19 vaccine hesitancy in the age of infodemic. *Hum Vaccin Immunother.* (2022) 18:2013694. doi: 10.1080/21645515.2021.2013694

25. Biswas MR, Alzubaidi MS, Shah U, Abd-Alrazaq AA, Shah Z. A scoping review to find out worldwide COVID-19 vaccine hesitancy and its underlying determinants. *Vaccines.* (2021) 9:1243. doi: 10.3390/vaccines9111243

26. Kanyanda S, Markhof Y, Wollburg P, Zezza A. Acceptance of COVID-19 vaccines in sub-Saharan Africa: evidence from six national phone surveys. *BMJ Open.* (2021) 11:e055159. doi: 10.1136/bmjopen-2021-055159

27. Wong LP, Alias H, Danaee M, Ahmed J, Lachyan A, Cai CZ, et al. COVID-19 vaccination intention and vaccine characteristics influencing vaccination acceptance: a global survey of 17 countries. *Infect Dis Poverty.* (2021) 10:1–14. doi: 10.1186/s40249-021-00900-w

28. Defar Hassan H, Welde M, Moges Menebo M. Understanding determinants of COVID-19 vaccine hesitancy; an emphasis on the role of religious affiliation and individual's reliance on traditional remedy. *BMC Public Health.* (2021) 22:1–11. doi: 10.1186/s12889-022-13485-2

29. Moola S, Gudi N, Nambiar D, Dumka N, Ahmed T, Sonawane IR, et al. rapid review of evidence on the determinants of and strategies for COVID-19 vaccine acceptance in low- and middle-income countries. *J Glob Health.* (2021) 11:05027. doi: 10.7189/jogh.11.05027

30. Lane S, MacDonald NE, Marti M, Dumolard L. Vaccine hesitancy around the globe: Analysis of three years of WHO/UNICEF Joint Reporting Form data-2015–2017. *Vaccine.* (2018) 36:3861–7. doi: 10.1016/j.vaccine.2018.03.063

31. Choi DH, Yoo W, Noh GY, Park K. The impact of social media on risk perceptions during the MERS outbreak in South Korea. *Comput Human Behav.* (2017) 72:422. doi: 10.1016/j.chb.2017.03.004

32. Griffiths F, Dobermann T, Cave JAK, Thorogood M, Johnson S, Salamatian K, et al. The impact of online social networks on health and health systems: a scoping review and case studies. *Policy Internet.* (2015) 7:473–96. doi: 10.1002/poi3.97

33. Li O. Getting the COVID-19 Vaccine. *Graph Med Rev.* (2021) 1:3. doi: 10.5164/gmr.26

34. Pang PCI, Cai Q, Jiang W, Chan KS. Engagement of Government Social Media on Facebook during the COVID-19 Pandemic in Macao. *Int J Environ Res Public Health.* (2021) 18:3508. doi: 10.3390/ijerph18073508

35. Huang Y, Su X, Xiao W, Wang H, Si M, Wang W, et al. COVID-19 vaccine hesitancy among different population groups in China: a national multicenter online survey. *BMC Infect Dis.* (2022) 22:1–12. doi: 10.1186/s12879-022-07111-0

36. King I, Heidler P, Marzo RR. The long and winding road: uptake, acceptability, and potential influencing factors of COVID-19 vaccination in Austria. *Vaccines.* (2021) 9:790. doi: 10.3390/vaccines9070790

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"Antibiotics are for everyone, our past and our future generations, right? If antibiotics are dead, we will be in big trouble": Building on community values for public engagement on appropriate use of antibiotics in Singapore

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Introduction: Shared decision-making (SDM) and trust building through continuity of care are known to play a pivotal role in improving appropriate antibiotic prescribing and use.

Problem: However, less is known about *how* to effectively leverage these factors when present—or overcome them when not—to address community needs and improve patient liaison.

Methods: We addressed this question using a convergent parallel mixed-methods design. Focus group discussions ($N = 13$; August 2018–September 2020), were analyzed alongside a nationally-representative cross-sectional survey ($N = 2004$; November 2020–January 2021), in Singapore. Descriptive quantitative analyses and multivariable logistic regression were undertaken to examine antibiotic knowledge and factors associated with preference for SDM. Qualitative applied thematic analysis was integrated with these data to further explain the findings.

Findings: Poor knowledge and misbeliefs on appropriate antibiotic use and antimicrobial resistance (AMR) were identified. For example, only 9% of the surveyed population understood that AMR occurs when the bacteria, not the human body, become resistant to antibiotics. Qualitative data corroborated the survey findings and suggested a shared value was placed on public education to avoid the fallout from resistant bacterial strains on current and future generations. This study also identified the opportunity to harness community trust in primary care doctors, who were described as highly valued educators for antibiotic use and AMR. Those who had trust in doctors were 75% more likely to prefer SDM (aOR 1.75, 95% CI 1.10−2.77, $P = 0.017$), especially adults aged ≥ 50 years who were receiving continued care with a regular doctor (aOR 1.83, 95% CI 1.18−2.86, $P = 0.007$). Continuity of care was observed to

value-add SDM by building trusting relationships, though it was often absent in younger populations.

Conclusion: This study highlights the long-term value-add of building on cultural capital pertaining to appropriate antibiotic use and AMR, by leveraging on the role of trust in doctors, desire for SDM and anchoring these in continuity of care when possible.

Recommendations: Using focused messaging and exploring alternative channels of communications such as annual check-ins or tele-consultations with a regular doctor, and emphasizing continuity of care across all age groups would help bridge the identified gaps.

Introduction

Global annual mortality attributable to antimicrobial resistance (AMR) was projected to reach 10 million by 2050 [1]. This estimated number is comparable with the annual global excess death count of an average of 7.5 million reported for the coronavirus disease 2019 (COVID-19) in the first 2 years of the pandemic [2], suggesting an urgent need to slow down AMR progression before it becomes the next pandemic.

Overprescribing of antibiotics is one of the major causes of AMR [3]. Reasons include patient demands, clinical uncertainties, fear of missing diagnosis, and fear of medico-legal issues [4–10]. However, one-sided information delivery through educational materials focused on encouraging doctors to improve appropriate antibiotic prescribing and nationwide campaigns to raise public awareness on AMR have limited effects [11–13]. In contrast, systematic reviews have shown that shared decision-making (SDM) between patients and doctors enables better chances of reducing inappropriate antibiotic prescribing and use [11, 14, 15]. Furthermore, the process of SDM is known to be buoyed up by receiving continuity of care from a regular doctor, and having mutual trust [7, 16–18]. The importance of these relationships has been explored in a qualitative study conducted amongst primary care doctors practicing in Singapore, which has positioned these constructs at the core of a VALUE model of SDM for antibiotic prescribing [18].

The model highlights the importance of starting with—building up when lacking or drawing on when present—the doctor's *own* values and organizational culture to adhere to

recommended practice and optimal patient care. Nevertheless, not every context will present the opportunity to influence or leverage such values. Continuity of care is not always possible, and trust takes time. In some cases, trust may be hard to win, if ever. To better navigate such scenarios, the central role of patients in navigating decisions around antibiotic use and adherence needs to be better understood. So far, existing literature indicates that the public's perceptions of SDM have been less explored, in favor of appraising satisfaction with clinical consultations post-SDM [11, 14].

Accordingly, the current study aims to better understand how to support the VALUE model's application in the primary care setting by accounting for the community's perspective and how to improve patient liaison around recommended antibiotic practices. We use a mixed-methods design informed by social and behavior change communication (SBCC) traditions [19] to firstly, assess gaps in knowledge, as well as intentions and behavioral follow-through to inform related *messaging* needs. Next, we examine for whom trust in doctors, continuity of care and SDM are valued to inform *targeting* for practitioner-led intervention design. Lastly, we explore the role of trust, how it is established and in particular how trusted sources can be leveraged *via* *multiple channels* to share information.

Our study defines SDM, following Elwyn et al. as a three-step process: (a) providing reasonable options to patients, (b) using decision aids to describe these, and (c) exploring patient preferences and making choices together with the doctor [20]. The planned analysis acknowledges these steps, starting with defining specific knowledge and intentions or behavioral gaps that help to define how "reasonable options" to use antibiotics appropriately should be messaged and communicated. In addition, we opted to dig deeper on understanding how to target these decision aids, building on a previous study conducted in Singapore, which highlighted that poor knowledge of antibiotic use and AMR in younger age groups drives larger extents of

inappropriate antibiotic practices (21). Lastly, best channels through which related information may be strategically used are assessed. Existing channels and campaigns in our present context are discussed below.

Overall, these analyses will help us identify areas for theory-informed intervention design and strategic implementation to improve antibiotic use in the primary care setting, *via* SDM processes, adding to what is already know from the practitioner's perspective, based on the existing identified VALUE-driven model (18).

Methods

Mixed-methods study design

This is a convergent parallel mixed-methods study. A nationally-representative community-based survey was conducted (November 2020–January 2021) on a randomly selected sample of Singapore residents (citizens and permanent residents) aged 21 years and above. The sampling frame and data collection methods are fully reported elsewhere (21). Separately, 13 focus group discussions (FGDs) were conducted (August 2018–September 2020). The Standards for Reporting Qualitative Research (SRQR) (22) was used to report qualitative methods, and quantitative procedures were integrated within.

All study methods and procedures were reviewed and approved by the National Healthcare Group Domain Specific Review Board of Singapore (Reference Number: 2017/01179).

Singapore context

The survey was conducted during the COVID-19 pandemic (November 2020–January 2021), after a national lockdown was lifted. Working adults, who were previously office-based, remained mostly in a "work-from-home" mode. Majority of students enrolled in higher learning institutes were attending classes online. On the other hand, FGD recruitment was disrupted by the COVID-19 pandemic (January 2020–August 2020) due to the early stages of national containment of community COVID-19 transmission. FGDs were resumed and completed in September 2020 with strict compliance to the nation's safe management measures.

Between 2018 and 2020, the annual AMR campaign message by the Singapore Health Promotion Board was "Fighting the flu virus is not my battle. Talk to your doctor for the treatment you need" (23). It was intensively disseminated through posters at public areas (bus stops, rapid transit system stations), brochures, tissue packs, television advertisements, social media posts and YouTube advertisements during the annual World Antibiotics Awareness Week in November.

Quantitative component

Survey instrument and variable selection

The survey questionnaire addressed antibiotic use and AMR. These included questions on knowledge, trust in information sources and doctors, as well as continuity of care, which were selected for analysis.

Knowledge questions were presented as True/False/Don't know. Questions on attitude and trust in doctors were presented in a 5-point Likert scale (strongly disagree to strongly agree) and dichotomized in the manner described below. Trust in information sources for health-related matters or medicines was presented in a 5-point Likert scale (never to completely) and dichotomized into 2 categories: trust (moderately/a lot/completely) vs. do not trust (never/rarely). Additional demographic information was also collected.

The dependent variable was defined by the statement "I would want my doctor to discuss with me and make the decision on antibiotic prescribing with me" (24). Respondents who agreed to this statement (strongly agree/agree) would be categorized as *preferring SDM on antibiotic prescribing with their doctors*. The independent variable on patient-acquired, all-round *trust in doctors* was tabulated using a composite score. It was composed of a 9-statement scale developed by Hall et al. (25), and agreement (strongly agree/agree) to all 7 positive statements, and disagreement (neither agree or disagree/disagree/strongly disagree) to both negative statements.

Positive statements included: (1) doctors in general care about their patients' health just as much as their patients do, (2) doctors are extremely thorough and careful, (3) I completely trust doctors' decisions about which medical treatments are the best, (4) doctors are totally honest in telling their patients about all the different treatment options available for their conditions, (5) doctors think only about what is best for their patients, (6) doctors always use their very best skill and effort on their patients, and (7) I have no worries about putting my life in the hands of doctors.

Negative statements were: (1) sometimes doctors care more about what is convenient for them than about their patients' medical needs, and (2) sometimes doctors do not pay full attention to what patients are trying to tell them.

Lastly, another independent variable on *continuity of care* was defined as reportedly seeking medical attention from a regular doctor.

Quantitative data analysis

Proportions were tabulated and chi-squared test was used to compare differences between them. Multivariable logistic regression was then performed to determine the independent factors associated with preference for SDM on antibiotic prescribing with doctors. Covariates were selected through assessing the Akaike information criteria, Bayesian information

criteria and likelihood ratios, and included in the final regression model to adjust for potential confounding. Interactions between covariates were individually explored and product terms were also included in the final model. Effect measure modification due to socio-demographic factors was further assessed. Statistical significance was defined as P-value <0.05. Statistical analyses were conducted in Stata version 14.0 (StataCorp LLC, College Station, Texas US).

Qualitative component

Researcher team composition and reflexivity

A semi-structured topic guide (Supplementary File Annex 1) was developed by HG (Female, MPH, Research Fellow) based on previous findings from the literature (26–32). Pilot interviews were conducted with co-workers of varying educational levels and with no prior medical knowledge to ensure content validity and proper phrasing of questions. Three research assistants, all females, bilingual graduates and trained in qualitative fieldwork, facilitated or took notes for the FGDs in the preferred language of the participants (English, Mandarin, Malay or Tamil).

Focus group discussions (FGDs) sampling and data collection

Invitation letters were disseminated to the community through community networks or recruitment drives. Interested members of the community left their contact details with the study team and were later contacted *via* email or telephone. Informed consent and basic demographic details were collected on the day of the FGD. Each FGD lasted for 90 mins. The topic guide consisted of questions pertaining to knowledge, attitudes and perceptions toward antibiotic use and AMR, antibiotic practices and also interactions with primary care doctors on the use of antibiotics.

Units of study

Singapore residents (citizens and permanent residents) aged 21 years and above were purposively sampled with maximum variation to ensure representation from different ethnic (Chinese, Malay and Indian) and age (21–49 years old and ≥50 years old) groups. A good mix of education level was also considered. To reach data and meaning saturation (33), at least two focus groups were required per stratum (i.e., older Chinese, younger Chinese, older Malay, younger Malay, older Indian and younger Indian). Hence, in this study, a minimum total number of 12 focus groups was planned. All potential participants were screened and included in the study if they were able to answer the question "Do you know what are antibiotics?."

Qualitative data processing and analysis

Each FGD was audio-recorded and data were transcribed verbatim. Applied thematic analysis was undertaken (34). Steps included data familiarization, segmenting the data according to topics pertinent to the current study objectives, and agreeing on a coding framework, as well as describing emergent themes. The coding framework was guided by identification of elements of VALUE model for antibiotic prescribing in the primary care setting (18). These included knowledge and understanding of antibiotic use and AMR, the presence and role of continuity of care, trusting patient-doctor relationship and active liaison with patients that lead to SDM processes on antibiotic prescribing. ATLAS.ti 9 was used to manage the qualitative data and record emergent themes.

Techniques to enhance trustworthiness of qualitative analysis

Regular meetings were conducted with a senior member of the team. Emergent themes and sub-themes were discussed and a consensus reached on the meaning of the data. Saturation was judged to have been achieved at over two-thirds of the way through the coding process.

Mixed methods reporting

Both datasets were analyzed separately and integrated at the reporting stage as appropriate. Qualitative main themes are reported by highlighting these in ***bold-italics***, while supporting themes are narrated alongside these. Each objective is addressed in turn.

Results

Out of 4791 households approached, 2004 (41.8%) respondents took part in the survey. They were representative of the Singapore population in 2020 (35), and most sought antibiotics from a GP and had a regular doctor (Supplementary Tables S1, S2). Thirteen FGDs were conducted, with a good distribution of ethnic groups and balance of education level, diversity of gender and ages was also achieved (Supplementary Table S3).

Informing messaging needs to improve knowledge of antibiotic use and antimicrobial resistance (AMR)

Descriptive quantitative analyses are summarized in Figures 1A–D. These findings are integrated with
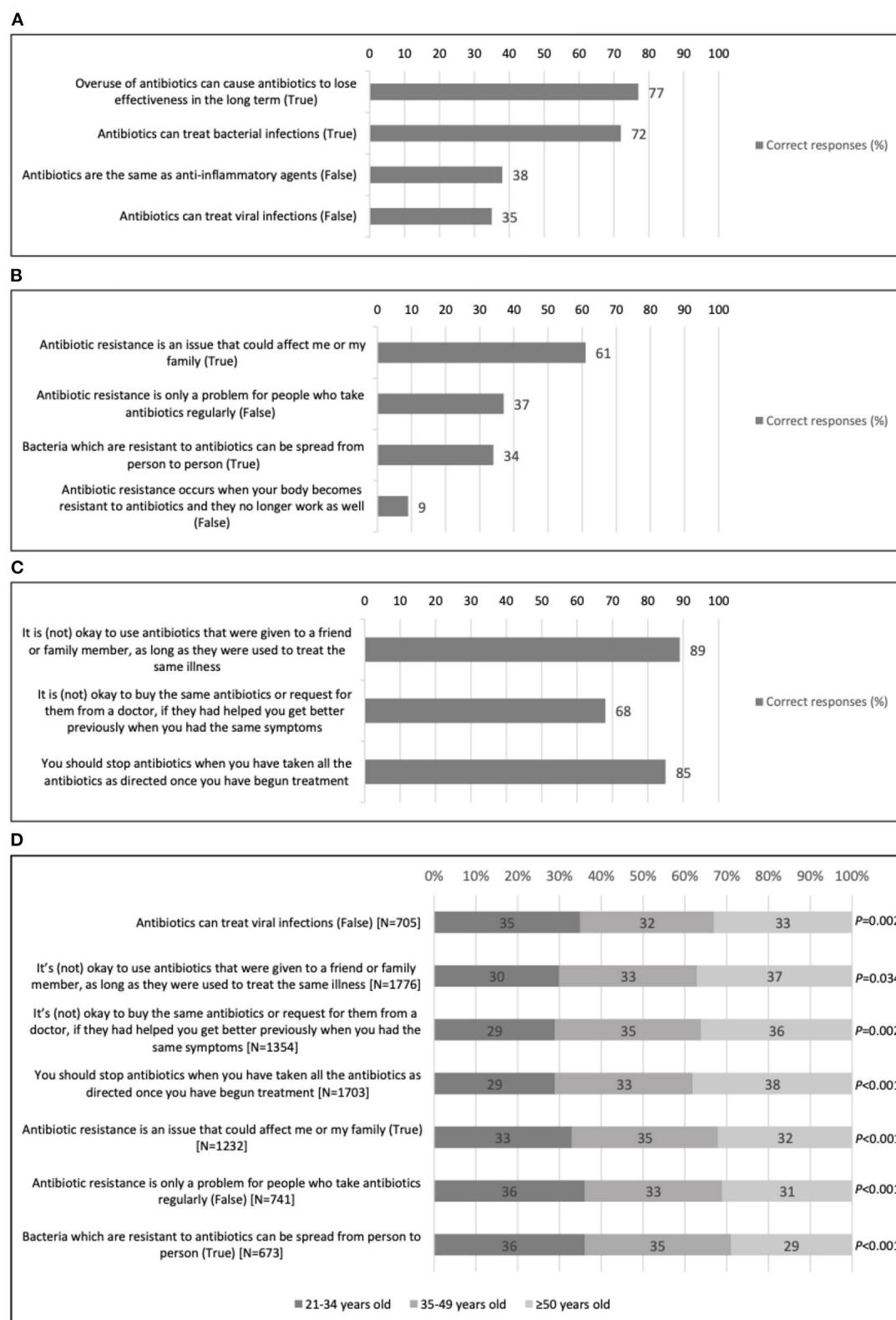
FIGURE 1
Proportion of correct responses from 2004 Singapore residents on statements pertaining to antibiotic use and antimicrobial resistance (AMR), surveyed between November 2020 and January 2021. **(A)** Knowledge of statements related to understanding how antibiotics work. **(B)** Knowledge of statements related to antimicrobial resistance (AMR). **(C)** Knowledge related to appropriate ways of obtaining and taking antibiotics. **(D)** Understanding differences in correct response in **(A–C)**, stratified by age (only significant trends reported).

TABLE 1A Gaps in knowledge, themes collated from focus group discussion data.

Themes	Sub-themes	Illustrative quotes
Specific gaps in the community's knowledge around reasons to take and minimize antibiotic use where appropriate	• Inability to differentiate between bacteria and viruses	"Antibiotics [are] for virus…if you're not in a medical line, you [will] get confused with bacteria, virus, germs…but I know that antibiotics are for viruses." -FGD11, Indian, 35–49 years old
	• Misconception that an antibiotic is the same as a painkiller, or an anti-inflammatory agent	"They said it was to reduce inflammation…Ya, for disinfection…Only take it when the illness is severe." -FGD03, Chinese, ≥50 years old
	• Overuse of antibiotics was seen as leading to the "body building immunity" against the antibiotics, not the bacteria itself becoming resistant	"If doctor gives you medications, once you are well…once you are healed, stop. If not, the next time you are sick…It's like body has become used to it…the immunity toward antibiotics is inside of us…our protection is no longer there. So even if we eat antibiotic, it would no longer be effective." - FGD02, Malay, ≥50 years old
Poor understanding of AMR	• Lay beliefs rather than scientific consensus were commonly being used to define the term "antibiotic resistance"	"Is it something where your body doesn't work on the antibiotics, already reached its maximum potency, like a dependency…It's like reached its limit…won't work for you anymore, is that it?" - FGD12, Indian, ≥50 years old
	• Misconception that effects of antibiotic resistance are cumulative by age	"So we are the pioneer. We eat more, we take more of this [referring to antibiotics]. When it comes to resistance…it is possible that is not very effective to the elderly. Because we already built up something inside [our body] already." - FGD04, Chinese, 35–49 and ≥50 years old

TABLE 1B Intentions and behavioral follow-through, themes collated from focus group discussion data.

Themes	Sub-themes	Illustrative quotes
While the best ways to obtain antibiotics and the advice on taking them was generally known, this did not always translate to good practices	• The misconception that the body, not the bacteria, became resistant was one reason why the full dose of prescribed antibiotics might not be completed	"I try not to finish in a way I got my body to be used to it [referring to antibiotics]." - FGD08, Chinese, 21–34 years old
	• Requesting tried-and-tested antibiotics was driven by the desire to recover from an illness faster	"Because I wanted to recover faster. I had some event [going] on, so I requested them because antibiotics normally works much faster. So I did request." - FGD10, Indian, 21–34 years old

qualitative thematic analyses, summarized in Tables 1, 2 with illustrative quotes.

Gaps in knowledge of antibiotic use and antimicrobial resistance (AMR)

Quantitative data showed a good understanding surrounding the need for using antibiotics cautiously and intentionally (Figure 1A). For instance, a large proportion knew that overuse of antibiotics can cause them to lose effectiveness in the long term (77%). It was also largely known that antibiotics are for the treatment of bacterial infection (72%), even though

other misconceptions existed. These misconceptions centered on far fewer recognizing the falsehood that antibiotics could be used to treat viral infection (35%) and believing that antibiotics had anti-inflammatory properties (38%).

Qualitatively, see Table 1A, we identified *specific gaps in the community's knowledge around reasons to take and minimize antibiotic use where appropriate*, which corroborated with the above.

These included the explicit inability to differentiate between bacteria and viruses. Also, the misconception that an antibiotic is the same as a painkiller, or an anti-inflammatory agent. Furthermore, the underlying rationale as to why the overuse of

TABLE 2A Univariate and multivariable logistic regression examining factors associated with preference for shared decision-making on antibiotic prescribing, N = 2004.

Variable	Do not prefer SDM (N = 280)	Prefers SDM (N = 1,724)	P-value	Univariate analysis			Model 1: Without interaction terms			Model 2: including interaction terms		
				Unadj. OR	95% CI	P-value	Adj. OR	95% CI	P-value	Adj. OR	95% CI	P-value
Trust in doctors, N (%)												
Yes	22 (8)	227 (13)	**0.012**	1.79	1.13–2.81	**0.014**	1.75	1.10–2.77	**0.017**	1.75	1.10–2.77	**0.017**
Has continuity of care with a regular doctor, N (%)												
Yes	156 (56)	1,077 (62)	**0.031**	1.32	1.03–1.71	**0.031**	1.27	0.98–1.65	0.075	0.93	0.60–1.45	0.746
Gender, N (%)												
Male	132 (47)	822 (48)	0.867	1.02	0.79–1.32	0.867	1.02	0.79–1.32	0.860	1.02	0.79–1.31	0.907
Age group, N (%)												
21–34 years old	94 (34)	521 (30)	0.507	Ref	–	–	Ref	–	–	Ref	–	–
35–49 years old	90 (32)	568 (33)		1.14	0.83–1.56	0.415	1.18	0.86–1.62	0.317	1.05	0.65–1.67	0.852
≥50 years old	96 (34)	635 (37)		1.19	0.88–1.62	0.259	1.37	0.97–1.93	0.075	0.94	0.58–1.52	0.796
Ethnic group, N(%)												
Non-Chinese	61 (22)	505 (29)	**0.010**	1.49	1.10–2.01	**0.010**	1.59	1.17–2.17	**0.003**	1.60	1.18–2.19	**0.003**
Highest educational level, N(%)												
Lower educated (Post-secondary & below)	105 (37)	591 (34)	0.294	Ref	–	–	Ref	–	–	Ref	–	–
Higher educated (Diploma & above)	175 (63)	1,133 (66)		1.15	0.89–1.49	0.294	1.36	1.01–1.82	**0.042**	1.38	1.03–1.85	**0.033**
Has ever had at least 1 chronic illness, N (%)												
No	188 (67)	1,168 (68)	0.840	1.03	0.79–1.35	0.840	–	–	–	–	–	–
Family member/friend working in healthcare sector, N (%)												
Yes	133 (47)	943 (55)	**0.025**	1.33	1.04–1.72	**0.025**	–	–	–	–	–	–
Interaction between continuity of care and being 35–49 years old												
Product term	–	–	–	–	–	–	–	–	–	1.29	0.68–2.44	0.425
Interaction between continuity of care and being ≥50 years old												
Product term	–	–	–	–	–	–	–	–	–	1.97	1.05–3.67	**0.034**

Bolded values indicate statistical significance of P < 0.05.

TABLE 2B Association between preference for shared decision-making on antibiotic prescribing and continuity of care, according to age group, $N = 2004$.

Preference for SDM	21–34 years old (N = 615)		35–49 years old (N = 658)			≥50 years old (N = 731)		
	OR	95% CI	OR	95% CI	P-interaction[a]	OR	95% CI	P-interaction[a]
Unadjusted analysis								
Lacks continuity of care	Ref	–	Ref	–	0.374	Ref	–	**0.007**
With continuity of care	0.98	0.63–1.53	1.23	0.78–1.93		1.83	1.18–2.85	
Adjusted analysis[b]								
Lacks continuity of care	Ref	–	Ref	–	0.425	Ref	–	**0.007**
With continuity of care	0.93	0.60–1.45	1.20	0.76–1.89		1.83	1.18–2.86	

[a]Multiplicative scale.
[b]Adjusted for trust in doctor, gender, ethnic group, and highest educational level.
Bolded values indicate statistical significance of $P < 0.05$.

antibiotics would interfere with their effectiveness in the long term was misunderstood: it was seen as leading to the "body building immunity" against the antibiotics, not the bacteria itself becoming resistant. Relatedly, one participant also had the erroneous thought that antibiotics are taken to strengthen one's immune system. These beliefs had influence over how antibiotics were taken, as explained below.

In general, the term "antibiotic resistance" was incomprehensible to the community (Figure 1B). Echoing previously shared qualitative findings, only 9% of the respondents realized that it is erroneous to believe that AMR occurs when the body becomes resistant to antibiotics. Relatedly, just 34% were aware that bacteria which are resistant to antibiotics can spread from person to person. Overarchingly, qualitative findings showed a *poor understanding of AMR* and indicated that lay beliefs rather than scientific consensus were commonly being used to define the term "antibiotic resistance."

The term was being used to infer mechanisms that only affect those who overdose on or overuse antibiotics, and therefore would need even more antibiotics to achieve an effect or the body itself had developed resistance to the antibiotic. Some expressed that the effects of antibiotic resistance were cumulative by age, since older adults would have taken more of such medications over their life time. Such rationales may explain why 61% of survey respondents reported that antibiotic resistance was an issue that may affect them or their families, despite most not understanding the mechanism by which this occurred.

Intentions and behavioral follow-through on antibiotic use

Most respondents in the survey reported that they understood that antibiotics should not be shared with others (89%) and that they should be taken as directed (85%)

(Figure 1C). Despite these quantitative results, focus group participants commonly shared that it was not unusual for them or their family members to not finish a full course of antibiotics once they started to feel better. Qualitative data highlights *while the best ways to obtain antibiotics and the advice on taking them was generally known, this did not always translate to good practices* (Table 1B). The misconception that the body, not the bacteria, became resistant was one reason why the full dose of prescribed antibiotics might not be completed.

In addition, 68% of survey respondents correctly responded that it would not be advisable to buy the same antibiotics or request them from doctors simply because these had helped with similar symptoms previously (Figure 1C); while focus group participants often described such a request as being reasonable because it was driven by the need to recover from an illness faster. There were small differences by age in knowledge (Figure 1D); in general, those aged 35 years and older were more apt at answering correctly on the appropriate ways of obtaining antibiotics while younger people had marginally better understanding of statements relating to AMR.

Targeted approaches stratified by age for improving public knowledge and appropriate antibiotic use

Quantitative descriptive results are collated in Figure 2 and regression analyses are summarized in Tables 2A,B. Analyses are presented by stratifying age, and they also built on existing findings which have shown that poor knowledge of antibiotic use and AMR and inappropriate antibiotic use in the general population are modified by age; with younger adults being less informed and likely to have worse outcomes (21).

FIGURE 2
Proportion of responses from 2004 Singapore residents, surveyed between November 2020 and January 2021, agreeing to these statements pertaining to trust in doctors, continuity of care and shared decision-making (SDM) for antibiotic prescribing, stratified by age.
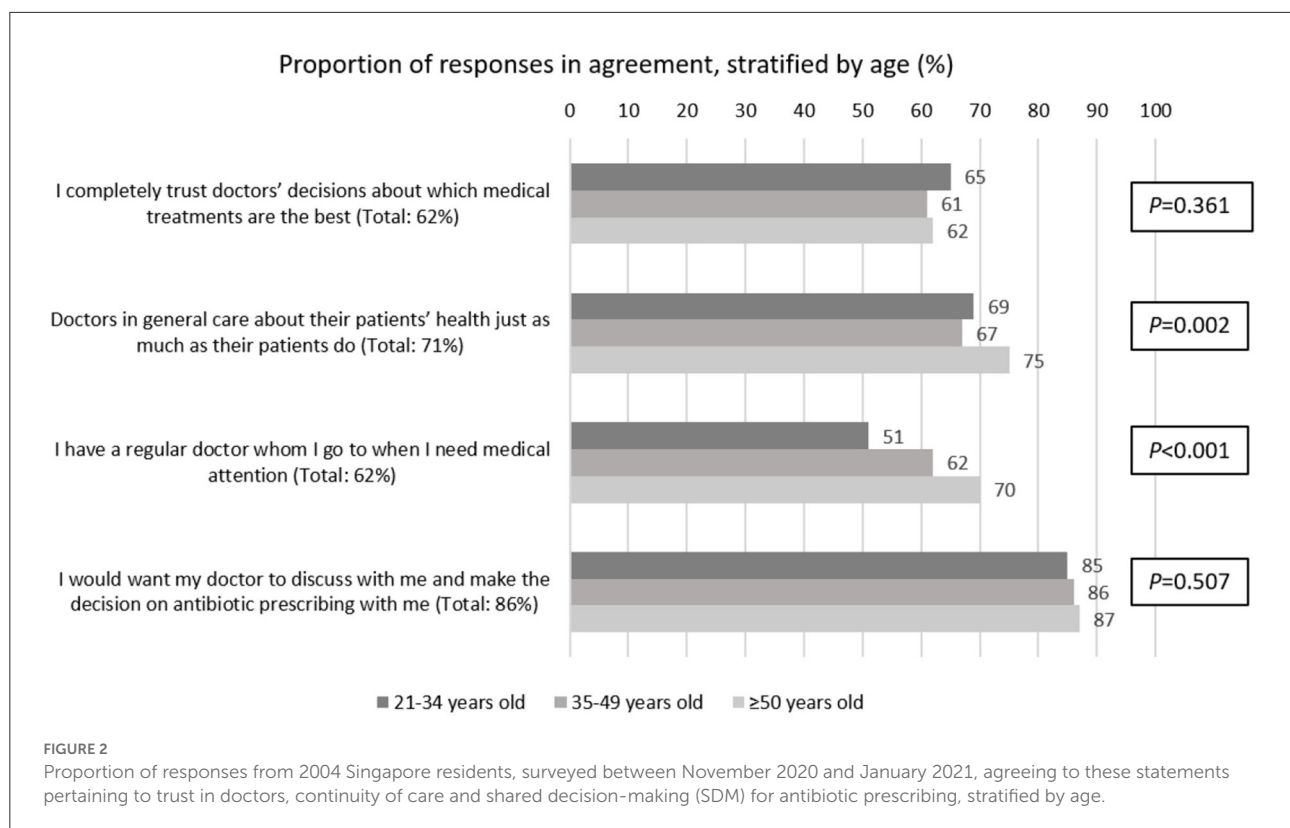
Trust, continuity of care, and shared decision-making (SDM)

Overall, in the present study, only a small majority of 62% reported having complete trust in doctors' decisions about which medical treatments are the best (Figure 2). Descriptive data showed a small effect of age relating to general trust in doctors, with those aged $\geq$50 years being most likely to believe that doctors in general care about their patients' health just as much as their patients do (21–34 years old: 69%; 35–49 years old: 67%; $\geq$50 years old: 75%, $P = 0.002$). Similarly, amongst the 62% of respondents who had continuity of care with a regular doctor, there were larger proportions of older respondents who medically attended with a regular doctor (21–34 years old: 51%; 35–49 years old: 62%; $\geq$50 years old: 70%, $P<0.001$). In contrast, quite a few more (86%) reported a preference for SDM but there was no statistically significant difference between age groups on such preference (21–34 years old: 85%; 35–49 years old: 86%; $\geq$50 years old: 87%, $P = 0.507$).

Upon adjusting for potential confounders, respondents who scored as trusting their doctors based on the scale measuring all-round trust in doctors, as developed by Hall et al. (25), were 75% more likely to prefer SDM when seeking antibiotic prescriptions (aOR 1.75, 95% CI 1.10–2.77, $P = 0.017$) (Table 2A). Though there was no significant effect from continuity of care on preference for SDM after adjusting for potential confounders, there was a significant multiplicative effect of age on these

associations (Table 2B). In those aged 50 years and above, it was found that when seeking antibiotics, those with continuity of care were 83% more likely to prefer SDM with their doctors, compared to those without it (aOR 1.83, 95% CI 1.18–2.86, $P = 0.007$).

Trust building and the use of multiple communication channels to promote education on appropriate antibiotic use and antimicrobial resistance (AMR)

Descriptive quantitative analyses stratified by age are listed in Figure 3. These findings are supplemented with qualitative thematic analysis, summarized with illustrative quotes in Tables 3A–C.

Though older people were shown to have better continuity of care and apparent interpersonal relationships with their doctors, trust in doctors was cross-cutting across age bands, see Figure 2, which shows no significant difference across age bands for having complete trust in doctors' decisions about medical treatments. Similarly, when asked about preferences for trusted sources to gain information on health-related matters or medicines (Figure 3), there were very small differences across age bands on preferences for doctors. Indeed, general

FIGURE 3
Proportion of trust on different health information sources of 2004 Singapore residents surveyed between November 2020 and January 2021, stratified by age. The * was used to denote categories with statistical significance.
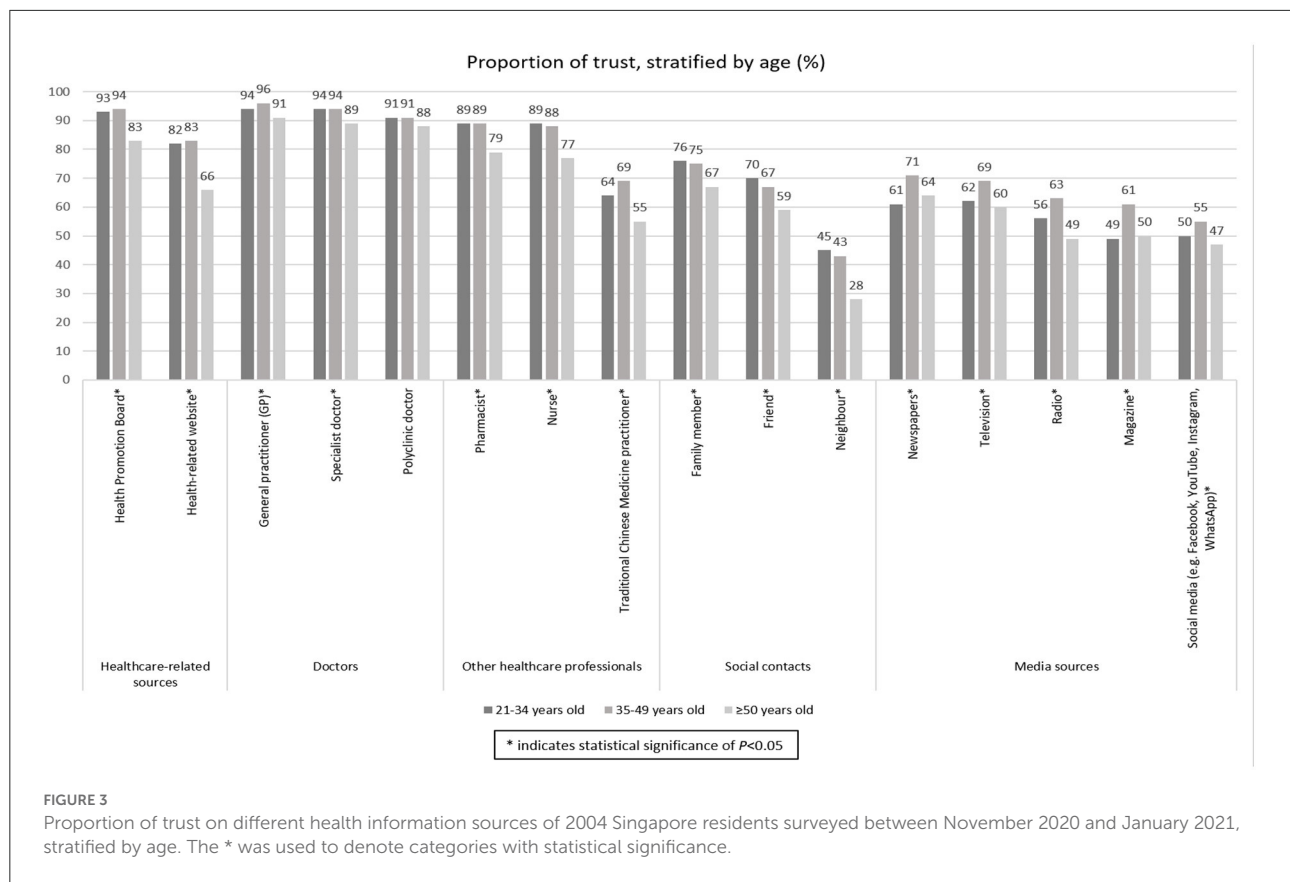
practitioners (GPs) were reported as most trusted by all age bands compared to all other proposed channels of acquiring information. However, younger people were more receptive to information by other health professionals such as nurses, as well as social contacts such as friends and family, than those over 50 years of age.

Qualitatively, consensus across the age bands emerged pertaining to main themes such as the *value-add through taking time to build trust* (Table 3A) and enable SDM, as shown in Table 2A. It was shared that in some cases, trust between patients and doctors was not a given. Ways of doing this pivoted around better communication and sharing of knowledge. There was a clear demand for and expression toward *valuing of public education on appropriate antibiotic use and AMR.* The importance of twinning trusted role of doctor with outreach and scientific information dissemination was pointed out as a basis for protecting current and future generations from the risks of antibiotics being rendered ineffective. This was corroborated by an observed lack of public outreach on AMR as compared to other chronic or lifestyle diseases, e.g., diabetes.

The valuing of SDM on antibiotic prescribing (Table 3B) was also notable by the expressed desire to have healthcare professionals as main focal point of education, supplemented by the use of other channels of communication and use

of decision aids. In addition, it was shared throughout the focus groups that initiation of SDM was experienced as a "matter of course"—it may or may not happen. Interestingly, communication to redress this lack of SDM, for instance tackling poor knowledge and empowering patients, was perceived as the doctor's responsibility.

Lastly, the *valuing of continuity of care* (Table 3C) was directly connected to valuing existing relationships with ones' doctors. Continuity of care was also enabled or hindered by practical factors, such as proximity, waiting times, speed and efficiency of diagnosis etc. It was clear that continuity of care, though often preferred, may not always be possible. Models of primary care provision will need to account for such situations and enable ways of encouraging seeking and receiving medically sound advice when the potential need for antibiotics presents, despite these limitations.

Discussion

This study provides important insights on what were the community's needs which should be addressed before and during SDM. It emphasizes the role of trust on educating patients to address their needs, promoting

TABLE 3A Trust building, themes collated from focus group discussion data.

Themes	Sub-themes	Illustrative quotes
Value-add through taking time to build trust	• In some cases, trust was not a given	"Too much false information out there. People no longer trust already. Even doctors, not a lot of people trust [them]." - FGD08, Chinese, 21–34 years old
	• Trust can be built by better communication and sharing of knowledge	"Because the doctor also did not inform us of anything. "You just eat this medication" like this…or breakdown what will happen…the doctor didn't let us know. Just asked us to finish eating this [referring to antibiotics], that's all we know." • FGD05, Chinese, ≥50 years old
Valuing of public education on appropriate antibiotic use and AMR	• Importance of twinning trusted role of doctor with outreach and scientific information	"For the general public, usually whatever instruction is given by the doctor, they [follow]. Because these are the doctor's instructions. But it's not being widely published in the newspapers, so we don't know enough [to understand why instructions are given as they are]." - FGD02, Malay, ≥50 years old "Everybody, should know about this issue, because antibiotics are for everyone, for our past and our future generations, right? If antibiotics are dead, we will be in big trouble." FGD04, Chinese, 35–49 yo and ≥50 years old
	• Observed lack of public outreach on AMR as compared to other chronic or lifestyle diseases, e.g., diabetes	"Most of the common people, the public, most of us, we are not alerted of this antibiotic resistance. We are not alerted, you see. So we don't know what [is the] cause, what is the outcome of it, the seriousness is that when you get antibiotic resistance." - FGD06, Malay, ≥50 years old "There were a lot of campaigns and there was a lot of awareness built around diabetes because it's a serious issue that we are handling. And just seeing it [referring to campaign messages] again and again and again, it's always at the back of your mind." - FGD10, Indian, 21–34 years old

continuity of care and influencing their acceptance and desire for SDM with their doctors on antibiotic prescribing in primary care settings. The central role of trust in driving the community's preference for SDM with their doctors on antibiotic prescribing was evident, with those who trusted their doctors being far more likely to prefer SDM, as compared to those who did not trust their doctors.

SDM was not an unfamiliar concept within the community, with many wanting this to happen when seeking antibiotics and others sharing that primary care doctors were already practicing this. However, the community lacked empowerment to actively take part in SDM, despite their desires, due to a lack of medical knowledge, as self-perceived and as shown in current and previous quantitative findings (21). Being equipped with right information to make informed choices is key during SDM (20). There were obvious knowledge gaps of both antibiotic use and AMR, and presence of misbeliefs surrounding these topics amongst the community, which translated to inappropriate antibiotic use.

These study findings are reflective of existing literature (21, 36–38), though our qualitative findings further revealed that there could be reasonable intentions behind undesirable antibiotic practices. Our study also informs a model of how to build on the community's valuing of SDM and leverage the importance of following appropriate antibiotic behaviors to minimize the potential for AMR development and preserve present and future generations' access to effective antibiotic treatments. Desired antibiotic behaviors include seeking medical consultation before taking antibiotics, rather than demanding them; following doctor's advice on how to take them; and not sharing them with others or stocking them for future use unnecessarily.

The mixed-methods data informs a model of strategic planning by using cultural capital to value-add, and build on what is known, using: tailored message content design following the 7Cs of public health communications (39) (see Supplementary Table S4, for suggested message content); funneling these into desired behaviors using appropriate,

TABLE 3B Shared decision-making, themes collated from focus group discussion data.

Theme	Sub-themes	Illustrative quotes
Valuing of SDM on antibiotic prescribing	● Expressed by the desire to have healthcare professionals as main focal point of education	"If you do too much mass education…it's meaningless to me. I don't know what is antibiotic because I don't take antibiotic, right? Unless I am sick and I need to take antibiotic, and the person who prescribes it to me or at the pharmacy tells me "You must make sure you finish this for this reason." That education will be very helpful. And maybe at the same time, give me a pamphlet. That way I will read and say, "Okay, I know why I need to complete."" ● FGD05, Chinese, ≥50 years old
	● Initiation of SDM was not experienced as a "matter of course"—it may, or may not happen	"From my personal experience, the doctor has never discussed it [referring to antibiotic prescribing] with me. And I think I would prefer that…perhaps, more doctors could discuss it with the patients." - FGD10, Indian, 21–34 years old "The doctor said, "I want to prescribe this medicine [referring to antibiotics]. What are your opinions."" - FGD09, Malay, 21–34 years old
	● Communication to redress the lack of SDM, for instance tackling poor knowledge and empowering patients, perceived as the doctor's responsibility	"From the point where the medicine is being prescribed…say "Okay, I'm going to give you this. Do you understand what you are taking? Do you understand the risk behind taking it, and properly taking it and what not properly taking it would do?" And then once you finish, sign it…you should make it mandatory for all GPs and healthcare providers." - FGD03, Chinese, ≥50 years old

TABLE 3C Continuity of care, themes collated from focus group discussion data.

Theme	Sub-themes	Illustrative quotes
Valuing of continuity of care	● Returning for follow-up consultations was directly connected to valuing existing relationships	"I always go and see the same doctor. Never [do I] go to other clinics… [if] my condition still did not improve, he will give me antibiotics." - FGD02, Malay, ≥50 years old "You know, think about the doctors, the queues just put me off."
	● Also, enabled or hindered by practical factors, such as proximity, waiting times, speed and efficiency of diagnosis etc.	● FGD11, Indian, 35–49 years old "If every time you visit that doctor and you don't recover, if every time you need to consult twice or thrice, then stop going there on the next time." -FGD01, Chinese, ≥50 years old

age-segmented, targeted, multi-channel intervention aids extracted from our findings (Figure 4). Message content needs to be clear and consistent regardless of communication modality used and, we suggest, spearheaded or endorsed by the highly trusted medical professionals, especially GPs, partnering with the Health Promotion Board or the Regional Health Systems through community-based campaigns. Traditional modes of communication such as hardcopy decision aids (including pamphlets) and newspaper articles are preferred and recommended for older adults (21, 40) but innovations to digitalize and/or gamify these materials and place at social

locations should be considered to reach the tech-savvy and highly social younger adults.

At the interpersonal level, first and foremost, the investment in building trusting relationships between patients and doctors will also value-add and is well known to make medical consultations more effective. The cyclical interdependency between continuity of care and trust is key to enabling SDM processes and must not be underestimated. The practices of enrolling with one primary care doctor should be recommended at the national level and patients making annual check-in visits (especially for older adults) or having tele-consultations
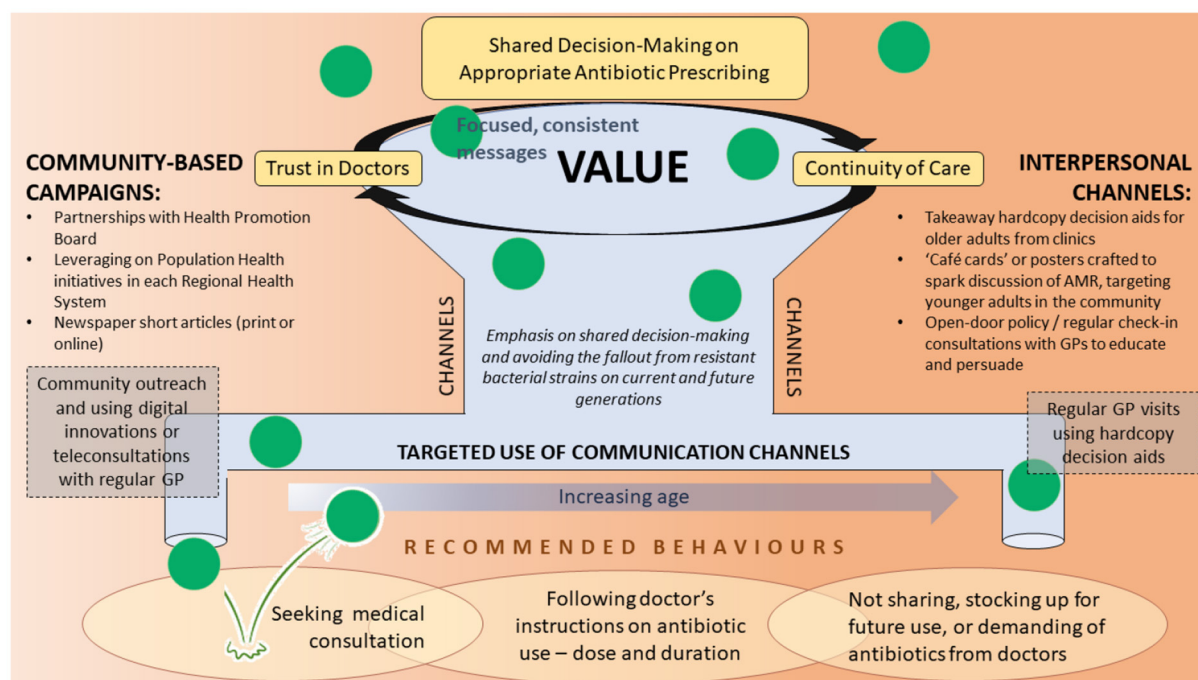
FIGURE 4
A strategic implementation model to guide the designing of interventions to improve appropriate antibiotic use in the general public.

with a regular doctor (particularly for younger adults) should be encouraged. These touch points should be harnessed to distribute decision aids or message cards with focused and consistent evidence-based messages on appropriate antibiotic use and AMR. These can also be made available on "café cards" or posters through identified community networks with messages crafted to spark discussion, social engagement and awareness of AMR, and the potential effects of this on current and future generations.

In fact, the strategy of engaging healthcare professionals as educators and SDM facilitators was well supported. As highlighted in a recent systematic review conducted to assess the role of education in antibiotic stewardship (41), the distribution of passive educational materials to educate patients on antibiotic use without the presence of an active educator yielded negligible effects on improving antibiotic prescribing in the primary care setting (42–45). In contrast, the active involvement of adult patients and parents in SDM processes, through the use of a visual tool to clarify their values and preferences on antibiotics *via* conversations with their doctors, resulted in a 25% reduction of unnecessary antibiotics prescribed for upper respiratory tract infections (46). Educational tools were found to be impactful only when used as SDM decision aids; public engagement and education were also recommended to involve both doctors and community partners (41).

Such a strategy should aim to consciously streamline and design information flow, appealing to both younger and older generations, and especially drawing in younger adults. Younger adults are known to passively gather a variety of information *via* personal and friendship networks (47–50), including the Internet. Campaigns focused on inter-generational benefits and encouraging sharing about how to avoid AMR will increase the diffusion of messages and effectiveness of campaigns.

Coincidentally, our recommended strategic model aligns with a recent national healthcare reform in the community to build a healthier population in Singapore. From 2023 onwards, enrolment to a single preferred primary care provider will commence under the "Healthier SG" initiative to encourage continuity of care to address different health needs of Singapore residents at different stages of life, with the involvement of multiple care and community partners to promote healthy living for different age sub-populations (51). Riding on this initiative, it would spare the arduous process of lobbying for policy change prior to implementing our strategy. Instead, our implementation model can be applied immediately to the Singaporean context, leveraging on the affirmative infrastructure which will be established through this upcoming healthcare reform.

Our study had several strengths. Firstly, the use of mixed methods provided in-depth qualitative understanding on the complexities surrounding the community context and constructs known to be of interest in persuading patients to take

antibiotics appropriately, namely, trust building, continuity of care, and SDM (18). Furthermore, for the survey component, we employed a robust sampling method to proportionately stratify and randomize accordingly, ensuring generalizability of quantitative results. Purposive, maximum variation sampling by age and ethnicity was used for the FGDs, to ensure a range of voices were captured for in-depth analysis, enabling transferability of findings. However, there was a low representation of participants aged 35–49 years from the Malay ethnic group.

Furthermore, we acknowledge the possibility of social desirability bias, which may have led study respondents to reduce their sharing of inappropriate antibiotic practices, though steps were taken to encourage open sharing, and emphasis placed on anonymity throughout data collection procedures. Finally, there could also be unknown confounders which were not adjusted for in the final logistic regression model.

Conclusion

The current study demonstrates how building trust with a consistent provider opens up opportunities to educate the community on appropriate antibiotic use and AMR. The use of focused and consistent messaging in the community, the enablement of continuity of care with a regular primary care doctor, and leverage on the cultural capital of valuing SDM, to protect current and future generations from the fallout of AMR, is emphasized.

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 studies involving human participants were reviewed and approved by Domain Specific Review Board, National Healthcare Group, Singapore. The patients/participants provided their written informed consent to participate in this study.

Author contributions

HG designed the FGD topic guide, co-designed the survey questionnaire, arranged and conducted training with the

surveyors, analyzed the data, and drafted the manuscript. ZH provided guidance on data analysis and critically revised the manuscript. AC conceived the study, provided overall direction and planning for the study, co-designed the survey questionnaire, and critically revised the manuscript. All authors contributed to the article and approved the submitted version.

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Conflict of interest

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

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpubh. 2022.1001282/full#supplementary-material

References

1. Review on Antimicrobial Resistance. *Antimicrobial Resistance: Tackling a Crisis for the Health and Wealth of Nations.* (2014). Available online at: https://amr-review.org/sites/default/files/AMR%20Review%20Paper%20-%20Tackling%20a%20crisis%20for%20the%20health%20and%20wealth%20of%20nations_1.pdf (accessed January 21, 2022).

2. World Health Organization. *14.9 Million Excess Deaths Associated With the COVID-19 Pandemic in 2020 and* 2021 (2022). Available online at: https://www.who.int/news/item/05-05-2022-14.9-million-excess-deaths-were-associated-with-the-covid-19-pandemic-in-2020-and-2021 (accessed May 6, 2022).

3. World Health Organization. *Antibiotic Resistance.* (2020). Available online at: https://www.who.int/news-room/fact-sheets/detail/antibiotic-resistance (accessed January 21, 2022).

4. Zetts RM, Stoesz A, Garcia AM, Doctor JN, Gerber JS, Linder JA, et al. Primary care physicians' attitudes and perceptions toward antibiotic resistance and outpatient antibiotic stewardship in the USA: a qualitative study. *BMJ Open.* (2020) 10:e034983. doi: 10.1136/bmjopen-2019-034983

5. Rose J, Crosbie M, Stewart A, A. qualitative literature review exploring the drivers influencing antibiotic over-prescribing by GPs in primary care and recommendations to reduce unnecessary prescribing. *Perspect Public Health.* (2021) 141:19–27. doi: 10.1177/1757913919879183

6. O'Connor R, O'Doherty J, O'Regan A, Dunne C. Antibiotic use for acute respiratory tract infections (ARTI) in primary care; what factors affect prescribing and why is it important? a narrative review. *Ir J Med Sci.* (2018) 187:969–86. doi: 10.1007/s11845-018-1774-5

7. Germeni E, Frost J, Garside R, Rogers M, Valderas JM, Britten N. Antibiotic prescribing for acute respiratory tract infections in primary care: an updated and expanded meta-ethnography. *Br J Gen Pract.* (2018) 68:e633–45. doi: 10.3399/bjgp18X697889

8. Lee TH, Wong JG, Lye DC, Chen MI, Loh VW, Leo YS, et al. Medical and psychosocial factors associated with antibiotic prescribing in primary care: survey questionnaire and factor analysis. *Br J Gen Pract.* (2017) 67:e168–77. doi: 10.3399/bjgp17X688885

9. Patel A, Pfoh ER, Misra Hebert AD, Chaitoff A, Shapiro A, Gupta N, et al. Attitudes of high vs. low antibiotic prescribers in the management of upper respiratory tract infections: a mixed methods study. *J Gen Intern Med.* (2020) 35:1182–8. doi: 10.1007/s11606-019-05433-5

10. Yates TD, Davis ME, Taylor YJ, Davidson L, Connor CD, Buehler K, et al. Not a magic pill: a qualitative exploration of provider perspectives on antibiotic prescribing in the outpatient setting. *BMC Fam Pract.* (2018) 19:96. doi: 10.1186/s12875-018-0788-4

11. Tonkin-Crine SK, Tan PS, van Hecke O, Wang K, Roberts NW, McCullough A, et al. Clinician-targeted interventions to influence antibiotic prescribing behavior for acute respiratory infections in primary care: an overview of systematic reviews. *Cochrane Database Syst Rev.* (2017) 9:CD012252. doi: 10.1002/14651858.CD012252.pub2

12. Price L, Gozdzielewska L, Young M, Smith F, MacDonald J, McParland J, et al. Effectiveness of interventions to improve the public's antimicrobial resistance awareness and behaviors associated with prudent use of antimicrobials: A systematic review. *J Antimicrob Chemother.* (2018) 73:1464–78. doi: 10.1093/jac/dky076

13. Lim JM, Singh SR, Duong MC, Legido-Quigley H, Hsu LY, Tam CC. Impact of national interventions to promote responsible antibiotic use: a systematic review. *J Antimicrob Chemother.* (2020) 75:14–29. doi: 10.1093/jac/dkz348

14. Coxeter P, Del Mar CB, McGregor L, Beller EM, Hoffmann TC. Interventions to facilitate shared decision making to address antibiotic use for acute respiratory infections in primary care. *Cochrane Database Syst Rev.* (2015) 2015:CD010907. doi: 10.1002/14651858.CD010907

15. Blyer K, Hulton L. College students, shared decision making, and the appropriate use of antibiotics for respiratory tract infections: a systematic literature review. *J Am Coll Health.* (2016) 64:334–41. doi: 10.1080/07448481.2015.1099105

16. Brookes-Howell L, Wood F, Verheij T, Prout H, Cooper L, Hood K, et al. Trust, openness and continuity of care influence acceptance of antibiotics for children with respiratory tract infections: a four country qualitative study. *Fam Pract.* (2014) 31:102–10. doi: 10.1093/fampra/cmt052

17. Barrera SC, Cancino RS, Barreto TW. The impact of continuity of care on antibiotic prescribing in acute otitis media. *Int J Pediatr Otorhinolaryngol.* (2019) 126:109616. doi: 10.1016/j.ijporl.2019.109616

18. Guo H, Hildon ZJ, Loh VWK, Sundram M, Ibrahim MAB, Tang WE, et al. Exploring antibiotic prescribing in public and private primary care settings in Singapore: a qualitative analysis informing theory and evidence-based planning for value-driven intervention design. *BMC Fam Pract.* (2021) 22:205. doi: 10.1186/s12875-021-01556-z

19. Nancy S, Dongre AR. Behavior change communication: past, present, and future. *Indian J Community Med.* (2021) 46:186–90. doi: 10.4103/ijcm.IJCM_441_20

20. Elwyn G, Frosch D, Thomson R, Joseph-Williams N, Lloyd A, Kinnersley P, et al. Shared decision making: a model for clinical practice. *J Gen Intern Med.* (2012) 27:1361–7. doi: 10.1007/s11606-012-2077-6

21. Guo H, Hildon ZJ, Lye DCB, Straughan P, Chow A. The associations between poor antibiotic and antimicrobial resistance knowledge and inappropriate antibiotic use in the general population are modified by age. *Antibiotics (Basel).* (2022) 11:47. doi: 10.3390/antibiotics11010047

22. O'Brien BC, Harris IB, Beckman TJ, Reed DA, Cook DA. Standards for reporting qualitative research: a synthesis of recommendations. *Acad Med.* (2014) 89:1245–51. doi: 10.1097/ACM.0000000000000388

23. Health Promotion Board. *Programmes: Antibiotics do Not Treat Flu.* (2021). Available online at: https://healthhub.sg/programmes/146/use-antibiotics-right (accessed January 21, 2022).

24. Center for Health Protection Department of Health. *General Public's Knowledge, Attitude and Practice Survey on Antimicrobial Resistance 2016/17.* (2017).

25. Hall MA, Camacho F, Dugan E, Balkrishnan R. Trust in the medical profession: conceptual and measurement issues. *Health Serv Res.* (2002) 37:1419–39. doi: 10.1111/1475-6773.01070

26. Cals JW, Boumans D, Lardinois RJ, Gonzales R, Hopstaken RM, Butler CC, et al. Public beliefs on antibiotics and respiratory tract infections: an internet-based questionnaire study. *Br J Gen Pract.* (2007) 57:942–7. doi: 10.3399/096016407782605027

27. Hawkings NJ, Butler CC, Wood F. Antibiotics in the community: a typology of user behaviors. *Patient Educ Couns.* (2008) 73:146–52. doi: 10.1016/j.pec.2008.05.025

28. Brooks L, Shaw A, Sharp D, Hay AD. Toward a better understanding of patients' perspectives of antibiotic resistance and MRSA: a qualitative study. *Fam Pract.* (2008) 25:341–8. doi: 10.1093/fampra/cmn037

29. Brookes-Howell L, Elwyn G, Hood K, Wood F, Cooper L, Goossens H, et al. 'The body gets used to them': patients' interpretations of antibiotic resistance and the implications for containment strategies. *J Gen Intern Med.* (2012) 27:766–72. doi: 10.1007/s11606-011-1916-1

30. Hoffmann K, Ristl R, Heschl L, Stelzer D, Maier M. Antibiotics and their effects: what do patients know and what is their source of information? *Eur J Public Health.* (2014) 24:502–7. doi: 10.1093/eurpub/ckt112

31. Gualano MR, Gili R, Scaioli G, Bert F, Siliquini R. General population's knowledge and attitudes about antibiotics: a systematic review and meta-analysis. *Pharmacoepidemiol Drug Saf.* (2015) 24:2–10. doi: 10.1002/pds.3716

32. Pan DS, Huang JH, Lee MH Yu Y, Chen MI, Goh EH, et al. Knowledge, attitudes and practices toward antibiotic use in upper respiratory tract infections among patients seeking primary health care in Singapore. *BMC Fam Pract.* (2016) 17:148. doi: 10.1186/s12875-016-0547-3

33. Hennink MM, Kaiser BN, Weber MB. What influences saturation? estimating sample sizes in focus group research. *Qual Health Res.* (2019) 29:1483–96. doi: 10.1177/1049732318821692

34. Guest G, MacQueen KM, Namey EE. *Applied Thematic Analysis* (2012).

35. Department of Statistics Singapore. *Singapore Census of Population* (2020).

36. Choo SJ, Chang CT, Lee JCY, Munisamy V, Tan CK, Raj JD, et al. A cross-sectional study on public belief, knowledge and practice toward antibiotic use in the state of Perak, Malaysia. *J Infect Dev Ctries.* (2018) 12:960–9. doi: 10.3855/jidc.10723

37. Lim JM, Chhoun P, Tuot S, Om C, Krang S, Ly S, et al. Public knowledge, attitudes and practices surrounding antibiotic use and resistance in Cambodia. *JAC Antimicrob Resist.* (2021) 3:dlaa115. doi: 10.1093/jacamr/dlaa115

38. Gillani AH, Chang J, Aslam F, Saeed A, Shukar S, Khanum F, et al. Public knowledge, attitude, and practice regarding antibiotics use in Punjab, Pakistan: a cross-sectional study. *Expert Rev Anti Infect Ther.* (2021) 19:399–411. doi: 10.1080/14787210.2021.1823216

39. World Health Organization. *Effective Communications: Participant Handbook: Communications Training Programme for WHO Staff.* London: Geneva (2015).

40. Guo H, Lim HY, Chow A. Health information orientation profiles and their association with knowledge of antibiotic use in a population with good Internet access: a cross-sectional study. *Antibiotics.* (2022) 11:769. doi: 10.3390/antibiotics11060769

41. Satterfield J, Miesner AR, Percival KM. The role of education in antimicrobial stewardship. *J Hosp Infect.* (2020) 105:130–41. doi: 10.1016/j.jhin.2020.03.028

42. Gonzales R, Sauaia A, Corbett KK, Maselli JH, Erbacher K, Leeman-Castillo BA, et al. Antibiotic treatment of acute respiratory tract infections in the elderly: effect of a multidimensional educational intervention. *J Am Geriatr Soc.* (2004) 52:39–45. doi: 10.1111/j.1532-5415.2004.52008.x

43. Mainous AG, Diaz VA, Carnemolla M. A community intervention to decrease antibiotics used for self-medication among Latino adults. *Ann Fam Med.* (2009) 7:520–6. doi: 10.1370/afm.1061

44. Smeets HM, Kuyvenhoven MM, Akkerman AE, Welschen I, Schouten GP, van Essen GA, et al. Intervention with educational outreach at large scale to reduce antibiotics for respiratory tract infections: a controlled before and after study. *Fam Pract.* (2009) 26:183–7. doi: 10.1093/fampra/cmp008

45. Vinnard C, Linkin DR, Localio AR, Leonard CE, Teal VL, Fishman NO, et al. Effectiveness of interventions in reducing antibiotic use for upper respiratory infections in ambulatory care practices. *Popul Health Manag.* (2013) 16:22–7. doi: 10.1089/pop.2012.0025

46. Légaré F, Labrecque M, Cauchon M, Castel J, Turcotte S, Grimshaw J. Training family physicians in shared decision-making to reduce the overuse of antibiotics in acute respiratory infections: a cluster randomized trial. *CMAJ.* (2012) 184:E726–34. doi: 10.1503/cmaj.120568

47. Wrzus C, Hänel M, Wagner J, Neyer FJ. Social network changes and life events across the life span: a meta-analysis. *Psychol Bull.* (2013) 139:53–80. doi: 10.1037/a0028601

48. Carstensen LL. Socioemotional selectivity theory: Social activity in life-span context. *Annu Rev Gerontol Geriatr.* (1991) 11:195–217.

49. Carstensen LL. Social and emotional patterns in adulthood: Support for socioemotional selectivity theory. *Psychol Aging.* (1992) 7:331–8. doi: 10.1037/0882-7974.7.3.331

50. Carstensen LL. Evidence for a life-span theory of socioemotional selectivity. *Curr Dir Psychol Sci.* (1995) 4:151–6. doi: 10.1111/1467-8721.ep11512261

51. Ministry of Health Singapore. *News Highlight: Promoting Overall Healthier Living While Targeting Specific Sub-Populations.* (2022). Available online at: https://www.moh.gov.sg/news-highlights/details/promoting-overall-healthier-living-while-targeting-specific-sub-populations (accessed September 6, 2022).

COVID-19 vaccine hesitancy: A narrative review of four South Asian countries

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Objectives: Vaccine hesitancy remains a global issue, especially within poverty-stricken countries where there's an interplay of financial and non-financial barriers. This narrative review aims to understand attitudes and behaviors toward COVID-19 vaccination in four South Asian countries and make context-specific recommendations to vaccine program drivers and decision-makers.

Methods: A search was conducted using PubMed and Science Direct, and CINHAL from January 2020 up to May 2022 restricted to the English language for terms: "Afghanistan" OR "Pakistan" OR "India" OR "Bangladesh" in combination with "COVID-19 vaccine" and other related terms. All articles were initially included, and those with relevance were included in the synthesis of this paper.

Results: A narrative review was performed for this study. Our narrative review included a total of eighteen studies with a sample size ($n = 223-5,237$) averaging about 1,325 participants per study conducted. The studies included revealed public hesitancy to receive the COVID-19 vaccine ranging from 6.3 to 56.2% with an average of 31.63% across all eighteen studies. Several reasons were linked to this observation in these four South Asian countries, and the predominant ones included: Insufficient information provided to the general public about the side effects of the vaccines, concerns regarding vaccine safety, and skepticism of vaccine efficacy.

Conclusion: Vaccine hesitancy is a global problem within the context of COVID-19, and issues regarding equity, misinformation, and poverty in South Asian countries makes it difficult to meet goals for herd immunity. Policymakers and governments should aim toward financial and non-financial incentives to drive the public toward vaccination.

KEYWORDS

COVID-19, vaccine hesitancy, public perspectives, public opinion, South Asia

Introduction

Vaccines are considered to be one of the most efficacious public health intercessions in preventing further disease progression and reducing mortality rates worldwide. Over the recent years, they have been increasingly employed in various successful outbreak-related response strategies proving their essential role in the abatement of communicable diseases (1, 2). Despite the paramount evidence provided by experts in this field, there still remains a prevailing public concern globally over the safety of these therapeutic agents (3). Vaccine hesitancy, as stated by the World Health Organization (WHO) is defined as a "delay in acceptance or refusal of vaccines despite availability of vaccination services" (4). This phenomenon is being observed in many communities and especially in the South Asian region where imputable causes are plenty.

Vaccine hesitancy poses a substantial threat to tackling pandemics and most notably, the current COVID-19 pandemic which relies heavily on vaccination rings and public uptake in creating herd immunity. The causes behind this alarming phenomenon vary but can be attributed to the shaken public trust in the services provided by the healthcare systems in these countries, various doubts and mistrust of the efficacy of such interventions, and the circulated false social media claims as well as a plethora of non-factual medical statements made by religious figures in these countries (5). Additionally, socio-demographic factors have been widely studied and have shown that people residing in urban areas, those with a lower education level and a lower family economic status are more likely to be hesitant to receive the vaccine (6).

The COVID-19 situation in South Asia, in particular in Afghanistan, Pakistan, India, and Bangladesh is highly critical as these countries are among the most poverty-stricken regions of the world, accounting for a substantial portion of COVID-19 cases globally with a total count of 47,580,486 cases to date (7). By understanding the public's behaviors and attitudes toward vaccinations, we can suggest key recommendations for expanding the coverage and help correct any vaccine-related misinformation that could relate itself to the denial or active rejection of this effective tool. Furthermore, the involvement of key health policymakers in improving the containment strategies in these countries could reflect an enhanced approach to vaccination implementation. Our narrative review aims to bring national attention to an already existing problem that has been further exacerbated by the COVID-19 pandemic and to consequently use the mentioned studies' findings to help deliver context-specific recommendations to vaccine program drivers and decision-makers, thereby increasing public confidence and trust in the accessible vaccines.

Materials and methods

A narrative review was performed using PubMed and ScienceDirect, and CINHAL from January 2020 up to May 2022. The search was restricted to the English language, in order to identify COVID-19 vaccine hesitancy in the included countries. The last search was performed on the 9th of May 2022. We included the following search terms: "Afghanistan" OR "Pakistan" OR "India" OR "Bangladesh" in combination with "COVID-19 vaccine" and "vaccine hesitancy" with any other relevant and identified synonyms. We included only survey-based studies with a primary outcome of COVID-19 vaccine hesitancy, which were conducted in South Asian countries. These studies investigated the perception, vaccine confidence, and vaccine hesitancy in these populations Following this initial literature review, we only included the articles which were pertinent to our research aims. The final database of studies included one of the four aforementioned countries with a clear focus on COVID-19 vaccine hesitancy amongst the public (Figure 1).

Results

The final pool of the studies comprised a sample size ranging from 223 to 5,237 participants with an average study sample of 1,325 and a total of 23,854 participants across all eighteen studies included (8–25). Our review included a total of one study from Afghanistan, five from Bangladesh, eight from India and four from Pakistan. Amongst the studies that explored reasons for vaccine hesitancy, it was noted that insufficient information provided to the public and increased concerns about vaccine safety and efficacy were identified as being the major arguments for COVID-19 vaccine refusal and hesitancy. Additionally, other reported reasons included the public perception that the COVID-19 vaccines might low-quality. Another common argument made was that people did not anticipate being infected with the virus hence, they did not feel the urge to seek the vaccines. From these four South Asian countries, we concluded that the prevalence of vaccine hesitancy for COVID-19 varied from 6.3 to 56.2% with an average rate of 31.63%.

Study participants included in this narrative literature review differed in age, gender, ethnicity, profession, the highest level of education attained, financial income, and marital status (Table 1).

Discussion

Vaccine hesitancy has been a prevailing concern reported by policymakers at varying levels, across as many as 90% of countries worldwide (26). Since the outbreak of the pandemic in

FIGURE 1
PRISMA flow diagram highlighting the selection process of the final studies included in this narrative review.
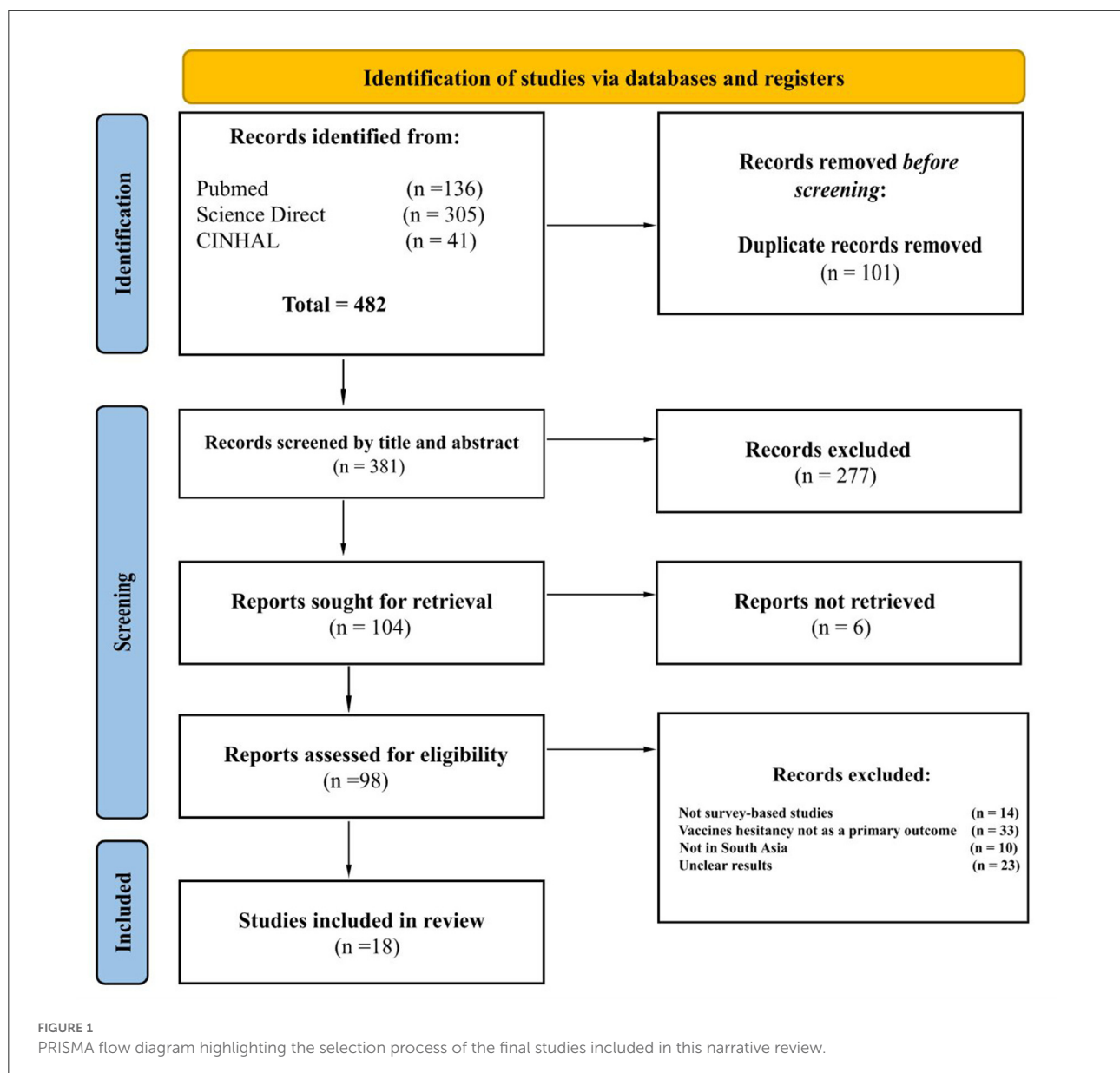
2020, a long journey of at least partially vaccinating 64.5% of the population across the globe, has been traversed (27). The issue of vaccine hesitancy remains a growing phenomenon, particularly during the COVID-19 pandemic. Unduly vaccine development efforts resulting in poor vaccine efficacy, and adverse reactions have been reported as some of the reasons behind the public's refusal to seek vaccines. Usually, the acceptability of a vaccine is said to have been influenced by the level of awareness about a disease, availability, and accessibility to a healthcare commodity (28).

Approximately, 49% of Pakistani citizens were reluctant to receive the COVID-19 vaccine (29). As of the 30th of April 2022, around 59.65% of the residents had been vaccinated (27).

A literature review by Nemat et al. reported that about 88% of Afghanis were aware of the efforts being made to develop vaccines for COVID-19. They also observed a significantly higher number of females than males, eager to receive the COVID-19 vaccine, this comes in contrast to a European survey suggesting the opposite (8). Paterson et al. reported that vaccine hesitancy is also prevalent among healthcare workers and especially medical students (30, 31). Since January 2021, the COVID-19 vaccination programs in India had initially prioritized the frontline healthcare workers and then gradually, spread its programs to cover the rest of the population. It is noteworthy to mention that 61.98% of India's citizens are fully vaccinated (27). Abedin et al. observed that 74.5% of Bangladeshi

citizens were keen to get the COVID-19 vaccination, resonating with France, Australia, Mexico, India, and Ireland, as confirmed by a population-based study conducted in these countries (32).

In addition, the assumed poor vaccine quality amongst the public, growing concerns over vaccine safety, and efficacy, rumors about clots during menstruation, and infertility have led to apprehensions regarding the COVID-19 vaccine. Few people even believed that the available vaccines may increase the mortality rate (6). Trust in the government due to inaccessible and inequitable distribution of economy and healthcare facilities among the communities, is also one of the major factors contributing to vaccine hesitancy. Furthermore, lack of technological literacy and poor refrigeration facilities adds to the dissimilar distribution of the COVID-19 vaccines across different regions in the same country.

Executing an effective mass vaccination drive demands the addressal of COVID-19 vaccine hesitancy. It is also essential to acknowledge various other factors which play an important role in these countries such as societal beliefs and literacy rates. Mass vaccination should be aimed at addressing the factors leading to vaccine hesitancy *via* interventions tailored to societal concerns and parameters, not restricted to any specific region.

The aim of the review is to illustrate the prevalence and describe the predictors of the COVID-19 vaccine hesitancy, in Pakistan, Afghanistan, India, and Bangladesh, with the latest available evidence, thereby, increasing the literature coverage in scoping. This will invaluably aid the various programs promoting vaccinations to raise awareness while addressing individual, economic, socio-cultural, political, and regional barriers. Specific proposals and recommendations formulated with the aid of public-private partnerships (PPP) would go a long way in combating this problem. The key to success in attaining herd immunity against COVID-19 mostly relies on the public uptake of the vaccines available. However, new emerging viral mutants, formed due to rapid antigenic shift and drift, are a constant challenge, which demands the attention of researchers worldwide.

Current efforts to combat COVID-19 vaccine hesitancy in these countries

In Pakistan, various efforts are being made at different levels to raise awareness about the efficacy of the COVID-19 vaccine, these include radio messages and large-scale video transmissions on TV and the internet providing the necessary adequate knowledge about vaccines and empowering the general public to accept the COVID-19 vaccine, as well as door-to-door vaccine administration and awareness drives similar to those used for Polio (33). Meanwhile, the government in India is not making any significant efforts to combat vaccine hesitancy; nevertheless, a "time-bound inquiry" into deaths that occurred

soon after vaccination was ordered, and each mobile phone call in the country was automatically initiated by a national programmed message from the Indian government affirming the safety and effectiveness of vaccines (34). Several initiatives are being implemented in Afghanistan to prevent vaccination hesitancy, including routine immunization vaccinators and the deployment of 2,000 more new health professionals (teams of two people: one male and one female), raising societal awareness and educating them, and avoiding myths (35). Similarly, in Bangladesh, the most popular variables contributing to decreasing vaccination hesitancy include social media and awareness campaigns (36).

To lessen the impact of vaccine hesitancy, it is imperative to critically analyze the situation based on different countries. Each country has a unique context that should be taken into consideration. Hence, varied policies are need to be enacted so as to ensure that each country can impede the impact of vaccine hesitancy.

Effects and recommendations of COVID-19 vaccine hesitancy in Afghanistan

In Afghanistan, the presence of conflict, illiteracy, and poverty has favored the condition for COVID-19 to continue spreading. Despite the country's high trends of other problems, the virus has only become a normal disease for some people. The continued spread has also impacted the uptake of the vaccines. A study conducted in the capital of Afghanistan, Kabul, revealed that 37% of the population is hesitant to receive the vaccine. In order to improve the situation, community engagements to raise awareness about the harmful effects of COVID-19 and the positive effects of the vaccines are important to be conducted. Moreover, social media awareness is also considered essential to improve the public's perception. However, it must be monitored to detect any source of misinformation and immediately stifle it. Lastly, in a country like Afghanistan, people pay great attention to religion and religious figures. Therefore, religious figures' engagement is crucial to raise awareness about important aspects of the vaccines (8).

Effects and recommendations of COVID-19 vaccine hesitancy in India

The Republic of India is not strange in facing vaccine hesitancy. This longstanding problem has resulted in a deferment in achieving the vaccination target for COVID-19. However, the Indian government is firmly strengthening its vaccination drives, *via* mass, print as well as social media coverage to help burst the myths surrounding the COVID-19

TABLE 1 Survey-based cross-sectional studies included in this narrative review relevant to COVID-19 vaccine hesitancy factors in Afghanistan, Pakistan, India, and Bangladesh.

SL	References	Country of origin	Study design	Time period	Study population	Sample size (n)	Prevalence of vaccine hesitancy (%)	Factors related to COVID-19 vaccine hesitancy
1	Nemat et al. (8)	Afghanistan	Cross-sectional	December 2020–January 2021	General population	806	42.4%	• "Lower income countries are supplied with low-quality vaccines" • "Vaccines are unsafe" • "I have enough immunity" • "Vaccines will be expensive"
2	Patwary et al. (9)	Bangladesh	Cross-sectional	5th of July 2021–August 2021	Bangladeshi residents over the age of 18	543	15%	• "Unknown side effects causing fear" • "Vaccines are not effective enough" • "Not enough information is provided on vaccines" • "Financial burden of the vaccines" • "COVID-19 is harmless" • "Natural immunity is better than vaccination" • "I have contraindications to the vaccines" • "I prefer if other people get vaccinated first"
3	Alam et al. (10)	Bangladesh	Cross-sectional	3rd of January 2021–25th of January 2021	Healthcare workers	831	33%	• "Unknown side effects of vaccines" • " Vaccine quality may be compromised due to mass production in a rush"
4	Hossain et al. (11)	Bangladesh	Cross-sectional	22nd of March 2021–1st of April 2021	Public university students	900	56.2%	• "I am worried about the vaccine side effects" • "I am not worried about COVID-19" • "Pandemics can be reversed without vaccines" • "Antibiotics can heal COVID-19 disease" • "Vaccines can be only applied to people who have been infected with COVID-19" • "Eating immune system boosting food can outperform vaccines" • "Vaccines should be given to patients with chronic health conditions"
5	Ali et al. (12)	Bangladesh	Cross-sectional	10th of October 2021–31st of October 2021	Parents aged ≥ 18 years and having at least one child aged < 18 years diagnosed with neurodevelopmental disorders	396	42.7%	• "Vaccines are not safe and effective for Bangladeshi children" • "None of my family members tested positive for COVID-19" • "None of my family members died of COVID-19" • "COVID-19 cannot infect us" • "We are not concerned at all about our children getting infected"

(Continued)

TABLE 1 (Continued)

SL	References	Country of origin	Study design	Time period	Study population	Sample size (n)	Prevalence of vaccine hesitancy (%)	Factors related to COVID-19 vaccine hesitancy
6	Ali et al. (13)	Bangladesh	Cross-sectional	10th of October 2021–31st of October 2021	Parents aged ≥ 18 years with children < 18 years of age	2,633	42.8%	• "Vaccines are not safe and effective for Bangladeshi children" • "I didn't receive a vaccine as a parent" • "None of my family members could be infected with COVID-19" • "We are not concerned at all about our children getting infected"
7	Kumar et al. (14)	India	Cross-sectional	During 2021	General population	841	27.2%	• "Concerns about vaccine safety" • "Antivaccine attitude and beliefs" • "Concerns of fear and phobia" • "New vaccine" • "Not in risk group" • "Lack of information"
8	Jain et al. (15)	India	Cross-sectional	2nd of February 2021–March 2021	Medical students	1,068	10.6%	• "Mistrust in vaccine safety" • "Vaccines are not efficacious enough" • "Young age" • "No need for vaccines as COVID-19 pandemic is over now" • "Previous COVID-19 exposure"
9	Joshi et al. (16)	India	Cross-sectional	10th of April 2021–10th of June 2021	Healthcare workers	223	6.3%	• "Insufficient information regarding the vaccine" • "Fear of unknown adverse effects" • "Doubt in vaccine effectiveness" • "Distrust in vaccine companies" • "Fear of vaccine's side effect on current pregnancy"
10	Jacob et al. (17)	India	Cross-sectional	2nd of January 2021–14th of January 2021	All adults over the age of 18	2,032	21.4%	• "Unknown side effects of the available vaccines" • "Vaccines are unnecessary" • "Mistrust in the country's authority" • "No perceived risk of COVID-19 infection" • "Cost of vaccine is not affordable"
11	Mathur et al. (18)	India	Cross-sectional	January 2021–February 2021	Healthcare workers	3,102	33.6%	• "I am worried about the side effects of the vaccine" • "Fear of needle prick" • "Fear of vaccine-induced COVID-19-like illness" • "Vaccine may be ineffective"

(Continued)

TABLE 1 (Continued)

SL	References	Country of origin	Study design	Time period	Study population	Sample size (*n*)	Prevalence of vaccine hesitancy (%)	Factors related to COVID-19 vaccine hesitancy
12	Singh et al. (19)	India	Cross-sectional	January 2021	Healthcare workers	254	35.8%	• "Not sure about the efficiency of vaccine" • "Worried about the side effects" • "Worried about effects of the vaccine on mental health" • "I am already infected; no need to vaccinate now"
13	Danabal et al. (20)	India	Cross-sectional	During 2021	All adults over the age of 18	564	40.7%	• " COVID 19 is not real" • "Vaccines are not powerful enough for this new virus COVID-19" • "Vaccines cause serious problems in children" • "Unknown long-term side effects of vaccine" • "COVID-19 vaccination is politically motivated" • "Vaccination programs are deceitful" • "Natural immunity lasts longer than vaccines" • "Natural exposure gives more protection"
14	Ekstrand et al. (21)	India	Cross-sectional	18th of January 2021–19th of February 2021	Individuals aged ≥18 years and diagnosed with HIV	438	40%	• "Lack of confidence in vaccines" • "Concerned about side effects" • "Distrust in vaccines"
15	Malik et al. (22)	Pakistan	Cross-sectional	3rd of December 2020 —14th of February 2021	Healthcare workers	5,237	24.5%	• "I have some religious concerns" • "Vaccines are not effective enough" • "Fear of vaccine side effects" • "Chronic comorbidities such as allergies, etc.." • "Previous exposure to COVID-19 infection"
16	Tahir et al. (23)	Pakistan	Cross-sectional	27th of September 2020–11th of October 2020	All adults over the age of 18	883	29.2%	• "COVID-19 is not a serious disease • "COVID-19 is a conspiracy" • "Vaccines have no role in disease prevention" • "I would become infected due to the vaccination" • "Unknown side effects are worrying me" • "Natural immunity is better than the vaccination" • "I am using protective measures against COVID-19" • "I am afraid of needles" • "I cannot afford the vaccine" • "I am concerned if the vaccine is "halal"" • "Vaccines are not properly stored in our country"

TABLE 1 (Continued)

SL	References	Country of origin	Study design	Time period	Study population	Sample size (n)	Prevalence of vaccine hesitancy (%)	Factors related to COVID-19 vaccine hesitancy
17	Yasmin et al. (24)	Pakistan	Cross-sectional	28th of January 2021–11th of February 2021	All adults over the age of 18	1,778	28%	• "I am concerned about side effects" • "I don't need a vaccine as I follow all preventive measures seriously" • "I don't believe the vaccine will stop the infection" • "COVID-19 vaccination is a conspiracy" • "I am young, healthy, and immune" • "I am afraid of needles"
18	Zak et al. (25)	Pakistan	Cross-sectional	July 2021–September 2021	Individuals aged $\geq$ 40 years	1,325	40%	• "Vaccines have side effects and are unsafe" • "It is not useful" • "Vaccine is not effective enough" • "My immune system is strong enough" • "There is no COVID" • "Vaccination is a Western/Jews/Israeli/American/Illuminati plot" • "I am stressed out" • "Religious reason" • "Due to some chronic conditions" • "Social pressure" • "Covid-19 vaccine-related stress/anxiety" • "Prior Covid exposure leads to the development of antibodies"

vaccines. It is also imperative to encourage joint efforts between district-level administrations and political leaders to dispel the hoax around COVID-19 vaccines through awareness sessions using regional folk songs.

Nevertheless, it is critical for the nation to develop an effectively sustainable campaign to tackle vaccine hesitancy. The government should invest in evidence-based research, as a public-private partnership, identify the population strata with distrust in vaccines with a resolute to resolve their hesitancy to expand wide immunization coverage. A versatile team comprising of experts from different fields such as immunology, pharmacology, microbiology, behavioral science, and sociology should be formulated at the national as well as, regional levels to conduct rigorous research and come up with solutions to help people accept the COVID-19 vaccines.

Communicating the advantages of vaccines in colloquial languages, backed by strong methodological proof of vaccine safety and efficacy, in addition to street plays to raise awareness, would pave the way in building the confidence of the masses in vaccines. Optimizing the support of mass media communications, and public posters to dismiss the hearsay and promote vaccines, besides, door-to-door campaigns conducted by social healthcare workers might be pivotal in instilling trust in vaccines (37).

Furthermore, rapid interventions are needed to accelerate the COVID-19 vaccination availability across the healthcare sectors and especially among individuals seeking the vaccines but facing inaccessibility to the vaccination centers. In order to encourage mass coverage, the administration should either make the vaccination available free of cost or provide reimbursement of the charges or tie up with the health insurance companies to cover the cost. Non-financial incentives, such as complimentary food items or a free health check-up, may also help out in the intention of combating vaccine hesitancy (38). Such sustained financial or non-financial incentives for vaccination coupled with public engagements would gauge the doubtfulness of the public and addresses their growing concerns.

Effects and recommendations of COVD-19 vaccine hesitancy in Bangladesh

According to many surveys conducted in Bangladesh, there has been significant vaccine hesitancy shown by the general public owing to personal beliefs, mistrust, religious factors, conspiracy theories, and concerns about vaccine safety - all of which have contributed to widespread misconceptions regarding vaccines. These incidents demand the immediate attention of Bangladesh's public health officials (9).

To clarify unfavorable public perceptions against the vaccination, an effective communication campaign engaging community members should be planned and conducted. Furthermore, it is paramount to ensure that accurate information on the COVID-19 vaccine procedure is constantly disseminated *via* effective media channels, such as the internet, TV news, and social media websites (39). Through these outlets, public health messages emphasizing faith in vaccination safety, efficacy, and benefits can be quite helpful. Public officials and national figures who have received the COVID-19 vaccination might also share their experiences in the media to urge others to become immunized. The authority should expand the number of community-based clinics and vaccination booths for online registration and immunization. With adequate administration, walk-in vaccination programs might be addressed. They can add extra personnel to properly handle the entire process. To combat this deadly disease, authorities must equip and teach their staff and other essential players. Furthermore, extensive coordination among academics, authorities, and societies is required to design a successful COVID-19 immunization program for all individuals (40).

All of these measures should be used by the authority to carry out its policy of broad COVID-19 immunization coverage. While it is challenging to manage misconceptions, it is essential to recognize inaccurate medical statements and circulated myths and work on rather promoting sound scientific facts regarding vaccination.

Effects and recommendations of vaccine hesitancy in Pakistan

Pakistan is also dealing with the rising issue of COVID-19 vaccination reluctance. It is one of the countries with the lowest vaccination rates. During these threatening times, COVID-19 vaccine hesitancy remains a significant barrier to Pakistan's public health. People from lower socioeconomic levels are less likely to be vaccinated. Fear of the vaccine's safety and efficacy, potential ill effects, lack of faith in vaccine-development institutions, and concern that the vaccination might cause autism, infertility, autoimmune diseases, and death are all factors impacting public adoption of the COVID-19 vaccine. As a result, Pakistan urgently needs to establish a stronger healthcare system to curb viral transmission (33, 41).

To urge people to get vaccinated against COVID-19, the Pakistani media must refrain from broadcasting anything that fuels conspiracy theories about the virus. An online telehealth programs should be established so that the any member of the public may direct their queries and concerns to specialists, who can reply and comment on vaccination safety. In the country, mass awareness campaigns should be conducted using various social media apps, TV channels, radio programs and newspapers as well. The priority should be placed on the importance of immunization by noting prior vaccine achievements (41).

Consideration should be given to the provision of financial incentives for vaccination. Religious conspiracies and erroneous beliefs about vaccines containing pig or monkey derivatives should be reduced by incorporating the religious experts and have them educate the general public about the necessity of immunization in accordance with Islamic Sharia law (23).

The major cause of vaccine refusal in this country is the lack of scientific understanding about vaccination among the general people; hence, the WHO must step up its duties to effectively address public inquiries and provide the most up-to-date scientific information about the available vaccines.

Limitations

This paper has several limitations. Given the nature of narrative reviews, the articles included in our study were not systematically reviewed, hence there exists an area for selection bias. Moreover, articles in the English language were only included which may have prevented us from accessing literature in other native languages across South Asia. In addition, conference proceedings and other databases such as Scopus were not included in our search which limited our final results. Our review only included cross-sectional studies that were survey-based while other studies including ones that analyze threads on social media platforms may have provided more insights since the use of such platforms increased during the pandemic. Also, qualitative studies may have given more in-depth descriptions of individual experiences. Collectively, these different factors could potentially add bias, and varying views may reflect different findings suggesting the diversity of opinions and conclusions.

Conclusion

With the rise in COVID-19 cases amidst new variants on a global scale, there is a strong need to tackle socio-economic challenges to vaccine uptake in developing countries, including vaccine hesitancy in the general population. Lower-and-middle income countries such as Afghanistan, Bangladesh, India, and Pakistan have shown the unique challenges to vaccinations along with lessons on successful implementation of cost-effective strategies in these regions. Further research is warranted on the role of vaccine misinformation and recommendations for unified health governance on this crucial matter.

Author contributions

FE contributed to the conceptualization of this manuscript, writing of the original draft, and review and editing. RQ contributed to the methodology, analysis of the data, and literature review. UU, PP, KQ, FN, and ZI contributed to the writing of the original draft. NZ contributed to the review and editing of the original draft. All authors contributed to the article and approved the submitted version.

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Conflict of interest

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

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References

1. Harris KM, Maurer J, Kellermann AL. Influenza vaccine — safe, effective, and mistrusted. *N Engl J Med.* (2010) 363:2183–5. doi: 10.1056/NEJMp1012333

2. Vetter V, Denizer G, Friedland LR, Krishnan J, Shapiro M. Understanding modern-day vaccines: what you need to know. *Ann Med.* (2018) 50:110–20. doi: 10.1080/07853890.2017.1407035

3. Fridman A, Gershon R, Gneezy A. COVID-19 and vaccine hesitancy: a longitudinal study. *PLoS ONE.* (2021) 16:e0250123. doi: 10.1371/journal.pone.0250123

4. The Lancet Child & Adolescent Health. Vaccine hesitancy: a generation at risk. *Lancet Child Adolesc Health.* (2019) 3:281. doi: 10.1016/S2352-4642(19)30092-6

5. Hawlader MDH, Rahman ML, Nazir A, Ara T, Haque MM, Saha S, et al. COVID-19 vaccine acceptance in South Asia: a multi-country study. *Int J Infect Dis.* (2022) 114:1–10. doi: 10.1016/j.ijid.2021.09.056

6. Marzo RR, Sami W, Alam MZ, Acharya S, Jermsittiparsert K, Songwathana K, et al. Hesitancy in COVID-19 vaccine uptake and its associated factors among the general adult population: a cross-sectional study in six Southeast Asian countries. *Trop Med Health.* (2022) 50:4. doi: 10.1186/s41182-021-00393-1

7. *COVID-19 | SAARC Region.* (2022). Available online at: http://www.covid19-sdmc.org/ (accessed July 1, 2022).

8. Nemat A, Bahez A, Salih M, Raufi N, Noor NAS, Essar MY, et al. Public willingness and hesitancy to take the COVID-19 vaccine in Afghanistan. *Am J Trop Med Hyg.* (2021) 105:713–7. doi: 10.4269/ajtmh.21-0231

9. Patwary MM, Bardhan M, Disha AS, Hasan M, Haque MdZ, Sultana R, et al. Determinants of COVID-19 vaccine acceptance among the adult population of Bangladesh using the health belief model and the theory of planned behavior model. *Vaccines.* (2021) 9:1393. doi: 10.3390/vaccines9121393

10. Alam ABMM, Azim Majumder MA, Haque M, Ashraf F, Khondoker MU, Mashreky SR, et al. Disproportionate COVID-19 vaccine acceptance rate among healthcare professionals on the eve of nationwide vaccine distribution in Bangladesh. *Expert Rev Vaccines.* (2021) 20:1167–75. doi: 10.1080/14760584.2021.1951248

11. Hossain ME, Islam MS, Ghose TK, Jahan H, Chakrobortty S, Hossen MS, et al. COVID-19 vaccine acceptability among public university students in Bangladesh: Highlighting knowledge, perceptions, and attitude. *Human Vacc Immunother.* (2021) 17:5089–98. doi: 10.1080/21645515.2021.2010426

12. Ali M, Proma TS, Tasnim Z, Islam MdA, Urmi TA, Ahmed S, et al. Parental COVID-19 vaccine hesitancy for children with neurodevelopmental disorders: a cross-sectional survey. *Trop Med Health.* (2022) 50:24. doi: 10.1186/s41182-022-00415-6

13. Ali M, Ahmed S, Bonna AS, Sarkar A, Islam MA, Urmi TA, et al. Parental coronavirus disease vaccine hesitancy for children in Bangladesh: a cross-sectional study. *F1000Res.* (2022) 11:90. doi: 10.12688/f1000research.76181.1

14. Kumar R, Bairwa M, Beniwal K, Kant R. COVID-19 vaccine acceptability, determinants of potential vaccination, and hesitancy in public: a call for effective health communication. *J Educ Health Promot.* (2021) 10:392. doi: 10.4103/jehp.jehp_327_21

15. Jain J, Saurabh S, Kumar P, Verma MK, Goel AD, Gupta MK, et al. COVID-19 vaccine hesitancy among medical students in India. *Epidemiol Infect.* (2021) 149:e132. doi: 10.1017/S0950268821001205

16. Joshi A, Sridhar M, Tenneti VJD, Devi V, K T S, Nallaperumal AB. COVID-19 vaccine hesitancy in healthcare workers amidst the second wave of the pandemic in India: A single centre study. *Cureus.* (2021) 13:e17370. doi: 10.7759/cureus.17370

17. Jacob J, Stephen S, Issac A, Krishnan N, Radhakrishnan RV, R VV, et al. Determinants of Willingness for COVID-19 vaccine: Implications for enhancing the proportion of vaccination among indians. *Cureus.* (2021) 13:e15271. doi: 10.7759/cureus.15271

18. Mathur M, Verma A, Mathur N, Singhal Y, Dixit M, Patyal A, et al. Predictors and Perceptions of Healthcare workers regarding vaccines safety in the initial phase of covid-19 vaccination drive in western part of India: A regression analysis. *Cureus.* (2022) 14:e21267. doi: 10.7759/cureus.21267

19. Singh AK, Kumari R, Singh S, Kandpal SD, Kaushik A. The dilemma of COVID-19 vaccination among Health Care Workers (HCWs) of Uttar Pradesh. *Indian J Community Health.* (2021) 33:319–24. doi: 10.47203/IJCH.2021.v33i02.017

20. Danabal KGM, Magesh SS, Saravanan S, Gopichandran V. Attitude towards COVID 19 vaccines and vaccine hesitancy in urban and rural communities in Tamil Nadu, India – a community based survey. *BMC Health Serv Res.* (2021) 21:994. doi: 10.1186/s12913-021-07037-4

21. Ekstrand ML, Heylen E, Gandhi M, Steward WT, Pereira M, Srinivasan K. COVID-19 vaccine hesitancy among PLWH in South India: implications for vaccination campaigns. *J Acq Immune Def Syndromes.* (2021) 88:421–5. doi: 10.1097/QAI.0000000000002803

22. Malik A, Malik J, Ishaq U. Acceptance of COVID-19 vaccine in Pakistan among health care workers. *PLoS ONE.* (2021) 16:e0257237. doi: 10.1371/journal.pone.0257237

23. Tahir MJ, Saqlain M, Tariq W, Waheed S, Tan SHS, Nasir SI, et al. Population preferences and attitudes towards COVID-19 vaccination: a cross-sectional study from Pakistan. *BMC Public Health.* (2021) 21:1759. doi: 10.1186/s12889-021-11814-5

24. Yasmin F, Asghar W, Babar MS, Khan H, Ahmad S, Hameed Z, et al. Acceptance rates and beliefs toward COVID-19 vaccination among the general population of Pakistan: a cross-sectional survey. *Am J Trop Med Hyg.* (2021) 105:1230–9. doi: 10.4269/ajtmh.21-0297

25. Zakar R, Momina A, Shahzad S, Hayee M, Shahzad R, Zakar MZ. COVID-19 vaccination hesitancy or acceptance and its associated factors: findings from post-vaccination cross-sectional survey from Punjab Pakistan. *Int J Environ Res Public Health.* (2022) 19:1305. doi: 10.3390/ijerph19031305

26. Khattak FA, Rehman K, Shahzad M, Arif N, Ullah N, Kibria Z, et al. Prevalence of Parental refusal rate and its associated factors in routine immunization by using WHO Vaccine Hesitancy tool: A Cross sectional study at district Bannu, KP, Pakistan. *Int J Infect Dis.* (2021) 104:117–24. doi: 10.1016/j.ijid.2020.12.029

27. *Coronavirus (COVID-19) Vaccinations - Our World in Data.* Available from: https://ourworldindata.org/covid-vaccinations (accessed July 3, 2022).

28. Feleszko W, Lewulis P, Czarnecki A, Waszkiewicz P. Flattening the curve of COVID-19 vaccine rejection—An International Overview. *Vaccines.* (2021) 9:44. doi: 10.3390/vaccines9010044

29. Gallup Pakistan. *Coronavirus Attitude Tracker Survey Pakistan.* (2020). Available from: https://gallup.com.pk/wp/wp-content/uploads/2021/01/Gallup-Covid-Opinion-Tracker-Wave-9-pdf.pdf (accessed July 3, 2022).

30. *Information Regarding COVID-19 Vaccine.* Available from: https://www.mohfw.gov.in/covid_vaccination/vaccination/index.html (accessed July 3, 2022).

31. Paterson P, Meurice F, Stanberry LR, Glismann S, Rosenthal SL, Larson HJ. Vaccine hesitancy and healthcare providers. *Vaccine.* (2016) 34:6700–6. doi: 10.1016/j.vaccine.2016.10.042

32. Abedin M, Islam MA, Rahman FN, Reza HM, Hossain MZ, Hossain MA, et al. Willingness to vaccinate against COVID-19 among Bangladeshi adults: Understanding the strategies to optimize vaccination coverage. *PLoS ONE.* (2021) 16:e0250495. doi: 10.1371/journal.pone.0250495

33. Mehmood Q, Ullah I, Hasan MM, Kazmi SK, Ahmadi A, Lucero-Prisno DE. COVID-19 vaccine hesitancy: Pakistan struggles to vaccinate its way out of the pandemic. *Ther Adv Vacc Immunother.* (2022) 10:251513552210776. doi: 10.1177/25151355221077658

34. Sarkar MA, Ozair A, Singh KK, Subash NR, Bardhan M, Khulbe Y. SARS-CoV-2 vaccination in India: considerations of hesitancy and bioethics in global health. *Ann Global Health.* (2021) 87:124. doi: 10.5334/aogh.3530

35. Wardak MF, Rahimi A, Ahmadi A, Madadi S, Arif S, Nikbin AM, et al. COVID-19 vaccination efforts: is Afghanistan prepared? *Am J Trop Med Hyg.* (2021) 105:1137–40. doi: 10.4269/ajtmh.21-0448

36. Hossain MS, Islam MS, Pardhan S, Banik R, Ahmed A, Islam MZ, et al. Beliefs, barriers and hesitancy towards the COVID-19 vaccine among Bangladeshi residents: findings from a cross-sectional study. *PLoS ONE.* (2022) 17:e0269944. doi: 10.1371/journal.pone.0269944

37. Chandani S, Jani D, Sahu PK, Kataria U, Suryawanshi S, Khubchandani J, et al. COVID-19 vaccination hesitancy in India: state of the nation and priorities for research. *Brain Behav Immunity Health.* (2021) 18:100375. doi: 10.1016/j.bbih.2021.100375

38. Rosen B, Waitzberg R, Israeli A. Israel's rapid rollout of vaccinations for COVID-19. *Isr J Health Policy Res.* (2021) 10:6. doi: 10.1186/s13584-021-00440-6

39. Ahmad Rizal AR, Nordin SM, Ahmad WFW, Ahmad Khiri MJ, Hussin SH. How does social media influence people to get vaccinated? The elaboration likelihood model of a person's attitude and intention to get COVID-19 vaccines. *Int J Environ Res Public Health.* (2022) 19:2378. doi: 10.3390/ijerph19042378

40. OECD. *Enhancing Public Trust in COVID-19 Vaccination: The Role of Governments.* (2021). Available from: https://www.oecd.org/coronavirus/policy-responses/enhancing-public-trust-in-covid-19-vaccination-the-role-of-governments-eae0ec5a/ (accessed June 29, 2022).

41. Khan YH, Mallhi TH, Alotaibi NH, Alzarea AI, Alanazi AS, Tanveer N, et al. Threat of COVID-19 vaccine hesitancy in Pakistan: the need for measures to neutralize misleading narratives. *Am J Trop Med Hyg.* (2020) 103:603–4. doi: 10.4269/ajtmh.20-0654

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Knowledge, practice and attitude toward anabolic hormones and nutritional supplements among people practicing sports in the MENA region before and during COVID-19 lockdown

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Introduction: During the COVID-19 lockdown, people's lifestyles have changed including their habits and physical activities. There has been an increase in anabolic hormones and nutritional supplement use among people who regularly do exercise in the MENA region. This study aims to assess knowledge, practice, and attitude toward the use of anabolic hormones and nutritional supplements among people who regularly exercise in the Middle East and North Africa (MENA) region and to compare their exercise habits and hormones and supplements usage between before and during COVID-19 lockdown.

Methods: A self-administrated online Google form survey was carried out between February 2021 and April 2021. Five thousand eight hundred forty-five participants who regularly exercise and aged ≥18 years responded to the questionnaire. The questionnaire was distributed through social media platforms and included five sections: demographic, training characters, knowledge, practice, and attitude.

Results: The participants mean age was 27.4 ± 8.6 years. Males represented 58.2 % of participants. 75.3% of the study participants had not used either hormones or supplements, and about 19% used supplements only. The mean percent score for knowledge, practice, and attitude were 39.3 ± 30.5, 1.1 ± 9.5, and 21.3 ± 23.8, respectively. Level of knowledge was higher among participants who worked in the medical field or as sports coaches. The practice was higher among male participants. The most commonly used anabolic hormones and nutritional supplements were steroids and proteins with bodybuilding being the most common purpose. Internet was the main source of information and pharmacy was the main source for procuring these

substances. There was a significant decrease in proteins, carbohydrates, and sports drinks used during the COVID-19 lockdown compared to before the COVID-19 lockdown, while a statistically significant increase in vitamins used during the COVID-19 lockdown compared to before COVID-19 lockdown.

Discussion: In the MENA region, there has been an increase in the use of anabolic hormones and nutritional supplements. Most of the population has low knowledge of the harmful effect of uncontrolled, uninformed and unmonitored use of these substances Therefore, increasing the awareness level of participants and sports coaches should be a priority to limit the unsupervised use of hormones and supplements.

Introduction

In January 2020, World Health Organization (WHO) proclaimed coronavirus disease 2019 (COVID-19) to be a public health emergency and identified the disease as a global pandemic on 11 March 2020 (1, 2). COVID-19 is an extremely infectious disease caused by a virus called severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) that is a member of the coronaviruses family (3). This highly contagious virus was first reported in Wuhan city, China and then spread to affect over 1.1 million cases in the Eastern Mediterranean Region as reported by the WHO in July 2020 (4). Based on WHO recommendations, governments all over the world begun to enforce social distancing, quarantine, and isolation to limit the disease spread (4, 5). Countries in the Middle East and North Africa (MENA) region started to close schools, religious places, malls, airports, and some countries even suspended the government departments (6). During this tenure of social distance and lockdown, people's behaviors and lifestyles have changed and these changes include eating habits and physical activities (7). Personal restrictions also can result in a lack of physical activity, especially in countries with complete lockdown, such as Jordan (8).

Currently, anabolic hormones and nutritional supplements are used widely in people associated with sports. People, who exercise, use these substances for different reasons, for example, to improve their abilities, to strengthen their muscles, or to look better (9). Anabolic hormones, such as insulin and testosterone, are substances that help in cellular growth by triggering the anabolic pathway. These substances can be also developed in labs as is the case with anabolic steroids (10). While nutritional supplements are concentrated forms of food components, vitamins and minerals are used mainly to improve health and avoid diseases (11, 12).

In the Middle East, there has been an increase in consumption of anabolic hormones and nutritional supplements. In Saudi Arabia, a study reported that among gym attendants around 7.9% use anabolic hormones, and 47.9% use nutritional supplements (9). While the percent of hormone users was 22.7% in Kuwait (13) and 22% in United Arab Emirates (UAE) (14). Studies reported that a large number of individuals who use these substances did not consult doctors before taking them (15, 16). Sports authorities and the public in Arab countries started to pay more attention to the effect of using these substance on the wellbeing of healthy young people (17). Inappropriate use of hormones and supplements may lead to serious side effects. In the case of hormones, it may lead to high blood pressure, infertility, prostate cancer, increased libido, mood swings, and aggressiveness (18, 19), while in the case of supplements, it may cause cardiovascular problems, kidney failures, and fluid retention (20).

There is limited information regarding people's knowledge, practice, and attitude toward the use of anabolic hormones and nutritional supplements in MENA region and if there was any change in their habits during COVID-19 lockdown. Therefore, this study aims to assess knowledge, practice and, attitude toward the use of anabolic hormones and nutritional supplements among people who regularly exercise in MENA region and to compare their habits for using anabolic hormones, nutritional supplements and for exercising between before and during COVID-19 lockdown.

Methodology

Study design and participants

This multicenter cross-sectional study was conducted in MENA region through an online survey between February 2021 and April 2021. The study was carried out across eighteen countries (Algeria, Bahrain, Egypt, Iraq, Jordan, Kuwait, Lebanon, Libya, Morocco, Palestine, Qatar, Saudi Arabia, Sudan,

Syria, UAE, and Yemen). Male and female participants with a minimum age of 18 years who regularly exercise were included in the study. We used convenience and snowball sampling method, in which we collected the data from participants who were accessible to fill the questionnaire. The sample size was calculated according to Charan and Biswas (21) and Arkin (22) equations with a minimum of 400 participants from each country (21, 22).

Study survey

The questionnaire was a self-administrated online Google form survey, available in Arabic and English languages. The questionnaire was divided into 5 main domains including: (1) Socio-demographic characteristics: age, sex, country geographic location, educational level, monthly income, job, marital status, smoking, weight before and during COVID-19 lockdown, fat percentage before and during COVID-19 lockdown, and height; (2) Training characteristics: total period of exercise, exercise frequency, diet, going to the gym; (3) Knowledge about hormones and supplements: side effects of anabolic hormones, nutritional supplements side effect, source of their information, who advised them to use it; (4) Practice regarding hormones and supplements use: types of hormones used, route of administration for hormones, types of supplements used, following with nutritionist, source for buying these substances, withdrawal symptoms if they stopped; (5) Attitude toward hormones and supplements: opinions regarding hormones and supplements benefits, reasons for the use, attitude toward the use of these substances.

Validation and pilot study

The questionnaire was designed based on previous studies in Saudi, Emirates, and Kuwait (9, 13, 14, 23). With an aim to validate the survey, five experts from the field of nutrition were requested to fill the online Google form survey. These experts evaluated the degree of relevance of each question in the questionnaire and if it can correctly measure knowledge, practice, and attitude toward the use of anabolic hormones and nutritional supplements. Post validation, pilot study was conducted in 20 to 30 participants from 16 different countries in the MENA region. Their reliability and internal consistency of the survey was assessed using Cronbach's alpha which was 0.911 for knowledge section and 0.769 for the attitude section.

Data collection

On the first page of the Google form, an option was provided to use one of two languages (Arabic or English). This helped participants from countries whose main language is not only

Arabic, for example Morocco and Iraq, to participate in the study. An online link was distributed through different social media platforms. People who agreed to participate used the link to access the survey that did not collect any personal or contact details.

Ethical consideration

Ethical approval was obtained from Institutional review board Committee (IRB) at the Sahel General Hospital, Lebanon. Participant's anonymity and confidentiality was ensured throughout the study and analysis. If participants submitted the answered survey, we considered that as consent to participate in the study.

Statistical analysis

Data from the online questionnaire was collected, verified, and used for statistical analysis using R Software version 3.5.2 (2018-12-20) – Eggshell Igloo. For baseline demographic and training characteristics, mean and standard deviation were used for continuous data, and count and percent were used for categorical data. A score of 0 and 2 was assigned for the answers in each knowledge, practice, and attitude section, where 0 represented the worst and 2 the best. Regarding questions of scaled answers, all answers below neutral were assigned a score of 0 and all answers above neutral were scored as 2 for easier scoring scale. For some KAP responses, at which scores were not be applicable, count and percent were used for description after excluding minor and inconsistent responses. A spearman correlation was analyzed between each two domains as the distribution of total scores of each of knowledge, attitude and practice had violated the normal assumption.

Results

From 5,845 responders to the questionnaire, 5,353 subjects (91.6%) were completely responding. The **knowledge** domain consists of 21 questions with 48.2% complete responding, the **attitude** domain consists of 7 questions with 48.5% complete responding and **practice** domain consists of 10 questions with 48.5% complete responding (Among those who were consuming hormones or supplements or both were). Inconsistent responds were excluded from the analysis which were 5 responds (0.1%) related to (age), 325 responds (5.6%) related to [Since when you started to do exercise? (months)], 89 responds (1.5%) related to (Your monthly income in dollar), 80 responds(1.4%) related to Fat percentage during COVID-19 lockdown, and 63 responds (1.1%) related to Fat percentage before COVID-19 lockdown.

A total of 5,845 participants responded to the questionnaire with a mean age of 27.4 ± 8.6 years. More than half of the

TABLE 1 Baseline demographic characteristics among study population.

Demographics	Subgroups	Total (N = 5,845)
Age	Mean (SD)	27.4 (8.6)
Sex	Female	2,442 (41.8)
	Male	3,403 (58.2)
Country of residence	Algeria	453 (7.8)
	Bahrain	179 (3.1)
	Egypt	539 (9.2)
	Iraq	424 (7.3)
	Jordan	375 (6.4)
	Qatar	66 (1.1)
	Kuwait	431 (7.4)
	Lebanon	449 (7.7)
	Libya	152 (2.6)
	Morocco	564 (9.6)
	Oman	1 (0.0)
	Palestine	438 (7.5)
	Saudi	438 (7.5)
	Sudan	445 (7.6)
	Syria	412 (7.0)
	Tunisia	3 (0.1)
	UAE	169 (2.9)
	Yemen	307 (5.3)
Geographic location	Rural	836 (14.3)
	Urban	5,009 (85.7)
Your highest educational level	Bachelors/Masters/Doctorate	3,597 (61.5)
	Diploma/Trade Qualification	1,026 (17.6)
	Primary	66 (1.1)
	Secondary/Intermediate/Higher Secondary	1,156 (19.8)
Do you work in the medical field	No	4,230 (72.4)
	Yes	1,615 (27.6)
Are you a sports coach	No	5,182 (88.7)
	Yes	663 (11.3)
Where do you work	Government Sector	1,138 (19.5)
	Housewife	234 (4.0)
	Private Sector	1,648 (28.2)
	Student	2334 (39.9)
	Unemployed	491 (8.4)
Marital state	Divorced	95 (1.6)
	Married	1,606 (27.5)
	Single	4,108 (70.3)
	Widowed	36 (0.6)
Your monthly income in dollar	Mean (SD)	740.0 (1,474.6)

(Continued)

TABLE 1 (Continued)

Demographics	Subgroups	Total (N = 5,845)
Weight. Before. COVID-19 lockdown, Kg	Mean (SD)	73.0 (18.2)
Weight. during. COVID-19 lockdown, Kg	Mean (SD)	74.1 (21.1)
Height, cm	Mean (SD)	168.3 (17.6)
Fat percentage before COVID-19 lockdown	Mean (SD)	19.1 (7.4)
Fat percentage during COVID-19 lockdown	Mean (SD)	20.0 (7.8)
Do you smoke?	No	4,533 (77.6)
	Yes	1,312 (22.4)
Do you use hormones and supplements?	Both of them	240 (4.1)
	Hormones only	45 (0.8)
	None-of them	4,404 (75.3)
	Supplements only	1,156 (19.8)

participants were male (58.2%) and most of the participants were urban (85.7%). In terms of educational qualification, 61.5% of participants had Bachelors, Masters or a Doctorate degree and 19.8% had secondary, intermediate, or higher secondary education. Professionally, regarding participants' occupations, it was observed that 27.6% of the study participants were working in the medical field while only 11.3% of participants were sports coaches; 39.9, 28.2, and 19.5% of participants were students, worked at private sector, and worked at Government sector, respectively. 70.3% of participants were single, 27.5% were married, 1.6% were divorced and 0.6% were widowed. The average monthly income of the participants was 740.0 ± 1474.6 US dollars. The average weight of the participants before and during COVID-19 lockdown was 73.0 ± 18.2 and 74.1 ± 21.1 kg, respectively. The average height was 168.3 ± 17.6 cm. The average fat percentage before and after COVID-19 lockdown was 19.1 ± 7.4% and 20.0 ± 7.8%, respectively. Of all the participants, 77.6% were non-smokers. As shown in Table 1, 75.3% of the study population did not use either anabolic hormones or nutritional supplements, 19.8% used only the nutritional supplements, 0.8% used only the anabolic hormones and 4.1% used anabolic hormones and nutritional supplements (Table 1).

Regarding training characteristics of the participants, 45.9% of the study population used to go to the gym before COVID-19 lockdown and 25.6% had a gym qualified trainer. The

TABLE 2 Baseline training characteristics among study population.

Training characters	Subgroups	Total (N = 5,845)
Since when started to do exercise (months)	Mean (SD)	18.3 (25.9)
How many times you exercise per week before COVID-19 lockdown?	Five times or more per week	988 (16.9)
	Four times a week	932 (15.9)
	Once a week	1,915 (32.8)
	Three times a week	1,135 (19.4)
	Twice a week	875 (15.0)
How many times you exercise per week during COVID-19 lockdown?	Five times or more per week	784 (13.4)
	Four times a week	773 (13.2)
	Once a week	2,307 (39.5)
	Three times a week	992 (17.0)
	Twice	989 (16.9)
How many hours you exercise per day before COVID-19 lockdown?	From half an hour to 1 h	1,856 (31.8)
	From 1 to 2 h	1,807 (30.9)
	Less than half an hour	1,811 (31.0)
	More than 2 h	371 (6.3)
How many hours you exercise per day during COVID-19 lockdown?	From half an hour to 1	2,073 (35.5)
	From 1 to 2 h	1,464 (25.0)
	Less than half an hour	2,046 (35.0)
	More than 2 h	262 (4.5)
Do you follow a special diet before COVID-19 lockdown?	No	4,088 (69.9)
	Yes	1,757 (30.1)
Do you follow a special diet during COVID-19 lockdown?	No	4,055 (69.4)
	Yes	1,790 (30.6)
Do you go to the gym?	No	3,165 (54.1)
	Yes	2,680 (45.9)
Is the trainer in the gym qualified has a certificate?	I don't go to the gym	2,381 (40.7)
	I don't know	1,233 (21.1)
	No trainer in the gym	291 (5.0)
	Not qualified	444 (7.6)
	Yes	1,496 (25.6)

average duration since they started to do exercise was 18.3 ± 25.9 months. The frequency and duration of exercise by participants before and during COVID-19 lockdown are summarized in Table 2. Before COVID-19 lockdown, 30.1% of the study population was following a special diet while 30.6% of participants followed a special diet during COVID-19 lockdown (Table 2).

The mean percent score of knowledge was 39.3 ± 30.5 and 11, 15, and 74% of participants were of high, moderate and low knowledge level, respectively. The mean percent score for attitude was 21.3 ± 23.8 with 4, 11, and 86% of participants had high, moderate, low attitude level, respectively. The mean percent score for practice was 1.1 ± 9.5; 1% of the participants showed high practice level while the remaining (99%) showed low practice level and none of the participants showed a moderate level in practice (Table 3 and Figures 1–5).

TABLE 3 The mean percent score for knowledge, attitude and practice.

		Knowledge	Attitude	Practice
Mean percent score	Mean ± SD	39.3 ± 30.5	21.3 ± 23.8	1.1 ± 9.5
KAP levels	High level	628 (11%)	205 (4%)	40 (1%)
	Moderate level	866 (15%)	622 (11%)	0 (0%)
	Low level	4,351 (74%)	5,018 (86%)	5,805 (99%)

As shown in Table 4 and Figure 6, knowledge level was positively correlated with attitude level with a very weak association (r = 0.14) and also positively correlated with practice level with a very weak association that can be negligible (r = 0.02) while the attitude level was also positively correlated with the practice level with a very weak association (r = 0.10).
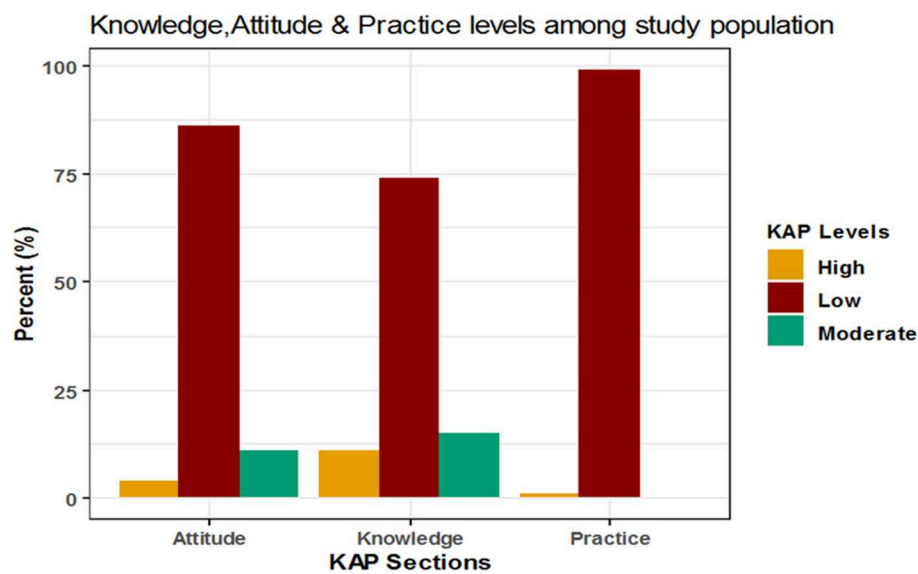
FIGURE 1
Levels of knowledge, attitude and practice.
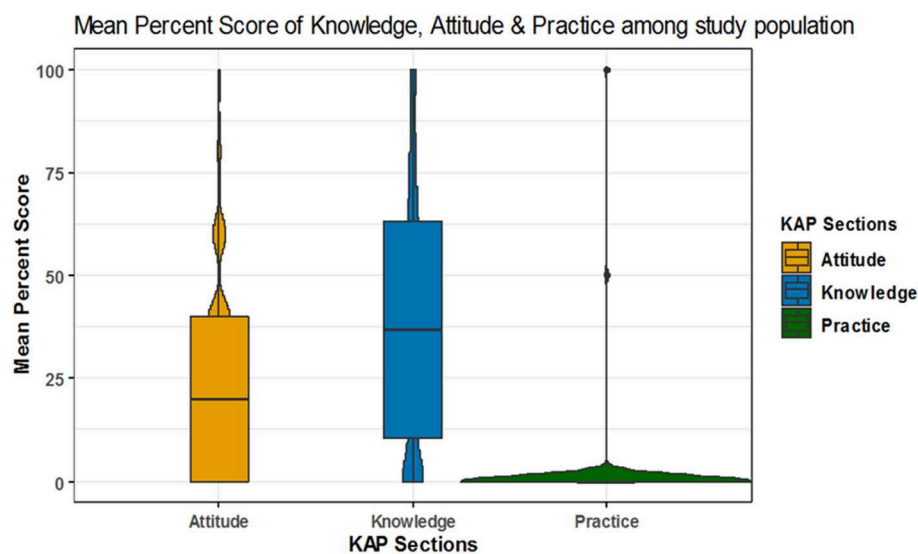
FIGURE 2
Mean percent score of knowledge, attitude and practice.

Univariate logistic regression model for the association between demographics and high level of knowledge

For each one-year increase in participant's age the odds of high level of knowledge increased significantly by 1% (OR = 1.01, 95% CI: 1.00–1.02, p = 0.031). Also Egyptian, Jordanian, Qatari, Kuwaiti, Lebanese, and Emirati participants showed significantly increased odds of high level of knowledge by 2.18 folds (OR = 2.18, 95% CI: 1.42–3.43, p = 0.001), 2.72 folds (OR = 2.72, 95% CI: 1.73–4.35, p < 0.001), 4.41 folds (OR = 4.41, 95% CI: 2.25–8.47, p < 0.001), 2.33 folds (OR = 2.33, 95% CI: 1.50–3.69, p < 0.001), 2.16 folds (OR = 2.16, 95% CI: 1.38–3.43, p = 0.001) and 2.19 folds (OR = 2.19, 95% CI: 1.25–3.82, p = 0.006) folds, respectively. On the contrary, Yemeni participants showed significantly decreased odds of high knowledge level by
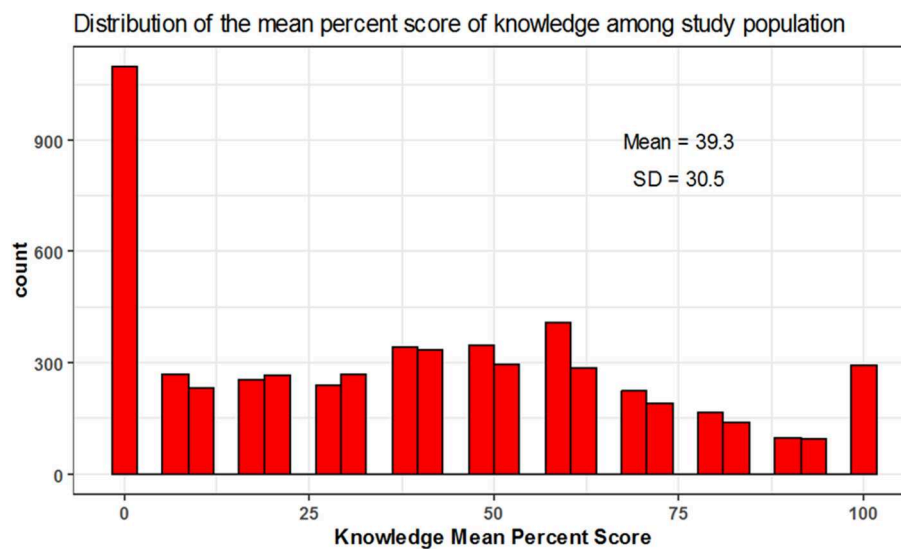
FIGURE 3
Mean percent score distribution for knowledge.
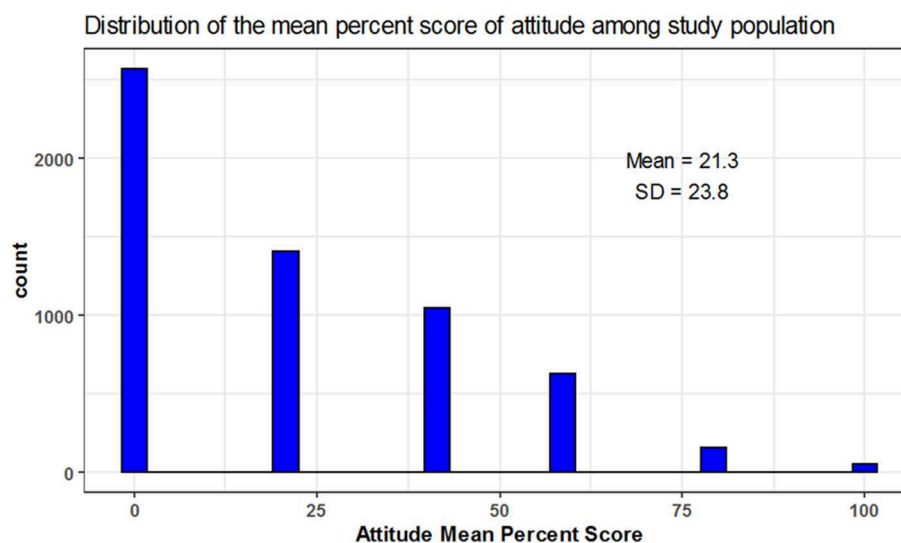
FIGURE 4
Mean percent score distribution for attitude figure.

about 53% when compared to Algerian participants (OR = 0.47, 95% CI: 0.23–0.90, p = 0.029).

Some difference in knowledge level was observed based on the qualification of the participants. Participants with diploma/trade qualification, primary and secondary, intermediate, higher secondary education showed significantly decreased odds of high knowledge level by nearly 37% (OR = 0.63, 95% CI: 0.49–0.80, p < 0.001), 81% (OR = 0.19, 95% CI: 0.03–0.60, p = 0.019) and 48% (OR = 0.52, 95% CI: 0.41–0.66, p < 0.001), respectively, when

compared to participants with bachelors, masters, or doctorate degree.

Based on the occupation, it was found that the participants working in the medical field showed significantly increased odds of high knowledge level by 2.39 folds when compared to participants who do not work in the medical field (OR = 2.39, 95% CI: 2.01–2.84, p < 0.001). Also, sports coaches showed significantly increased odds of high knowledge level by 51% when compared to participants who are not sport coached (OR = 1.51, 95% CI: 1.17–1.91, p = 0.001). Also, participants working
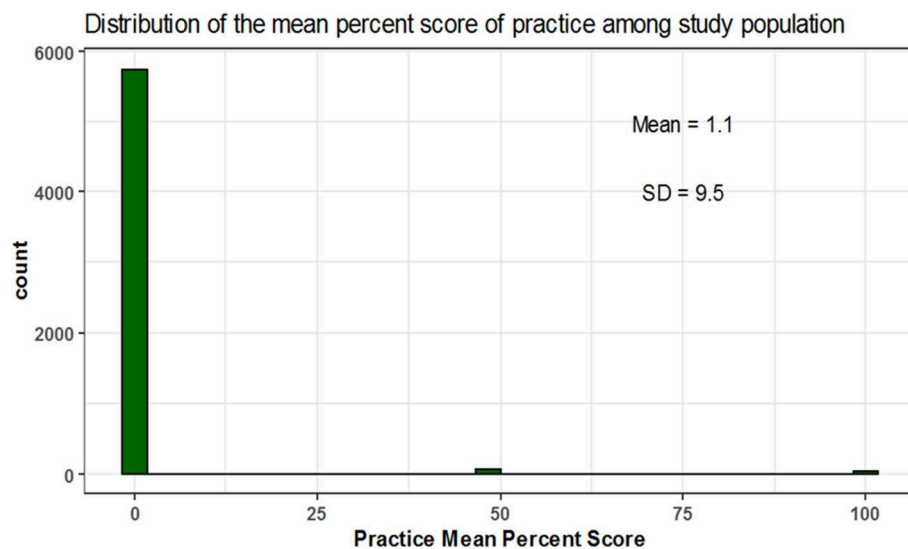
FIGURE 5
Mean percent score distribution for practice.

TABLE 4 Correlation between knowledge, attitude and practice total score.

	Knowledge	Attitude	Practice
Knowledge	1.00	0.14	0.02
Attitude	0.14	1.00	0.10
Practice	0.02	0.10	1.00
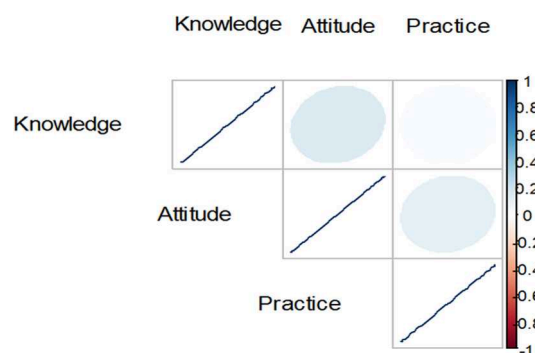
FIGURE 6
Correlation between knowledge, attitude, and practice.

in private sector, studying and unemployed participants showed significantly decreased odds of high knowledge level by 33% (OR = 0.67, 95% CI: 0.53–0.85, $p = 0.001$), 24% (OR = 0.76, 95% CI: 0.62–0.95, $p = 0.016$), and 48% (OR = 0.52, 95% CI: 0.36–0.75, $p = 0.001$), respectively, when compared to participants working in government sector.

Fat percentage also correlated with the level of knowledge. The odds of high knowledge level increased significantly by 2% (OR = 1.02, 95% CI: 1.00–1.03, $p = 0.006$) and 1% (OR = 1.01, 95% CI: (1.00–1.02), $p = 0.013$) for each one unit increase in the fat percentage in participants before COVID-19 lockdown and during COVID-19 lockdown, respectively.

Table 5 shows that the odds of high knowledge level also increased significantly by 2.81 folds (OR = 2.81, 95% CI: 1.01–7.24, $p = 0.037$) and 99% (OR = 1.99, 95% CI: 1.21–3.54, $p = 0.012$) among participants who used anabolic hormones only and among participants who did not use either anabolic hormones or nutritional supplements, respectively, when compared to the participants who used both the anabolic hormones and nutritional supplements.

Adjusted logistic regression model for the association between demographics and high level of knowledge

The adjusted odds of high level of knowledge increased significantly among participants from Bahrain, Egypt, Jordan, Qatar, Kuwait, Lebanon, Morocco and UAE by about 2 folds (OR = 2.10, 95%CI: (1.11–3.90), $p = 0.021$), 1.8 folds (OR = 1.82, 95%CI: (1.15–2.95, $p = 0.012$), 2.4 folds (OR = 2.45, 95%CI: (1.51–4.05, $p < 0.001$), 6 folds) OR = 6.03, 95%CI: (2.90–12.39, $p < 0.001$), 2.5 folds (OR = 2.50, 95%CI: (1.51–4.22, $p < 0.001$), 2.6 folds (OR = 2.58, 95%CI: (1.60–4.24, $p < 0.001$), 74% (OR = 1.74, 95%CI: (1.08–2.86, $p = 0.025$) and 2.6 folds (OR = 2.64, 95%CI: (1.40–4.95, $p = 0.002$), respectively, when

TABLE 5　Logistic regression models for the association between demographics and high level of knowledge.

Demographics		Low	High	OR (univariable)	OR (multivariable)
Age	Mean (SD)	27.3 (8.7)	28.1 (8.9)	1.01 (1.00–1.02, $p = 0.031$)	1.01 (1.00–1.03, $p = 0.170$)
Sex	Female	1,789 (86.6)	276 (13.4)	–	–
	Male	2,562 (87.9)	352 (12.1)	0.89 (0.75–1.05, $p = 0.178$)	1.07 (0.85–1.36, $p = 0.551$)
Country of residence	Algeria	337 (91.3)	32 (8.7)	–	–
	Bahrain	136 (87.2)	20 (12.8)	1.55 (0.84–2.78, $p = 0.148$)	2.10 (1.11–3.90, $p = 0.021$)
	Egypt	357 (82.8)	74 (17.2)	2.18 (1.42–3.43, $p = 0.001$)	1.82 (1.15–2.95, $p = 0.012$)
	Iraq	331 (91.4)	31 (8.6)	0.99 (0.59–1.66, $p = 0.958$)	1.11 (0.64–1.94, $p = 0.711$)
	Jordan	236 (79.5)	61 (20.5)	2.72 (1.73–4.35, $p < 0.001$)	2.45 (1.51–4.05, $p < 0.001$)
	Qatar	43 (70.5)	18 (29.5)	4.41 (2.25–8.47, $p < 0.001$)	6.03 (2.90–12.39, $p < 0.001$)
	Kuwait	303 (81.9)	67 (18.1)	2.33 (1.50–3.69, $p < 0.001$)	2.50 (1.51–4.22, $p < 0.001$)
	Lebanon	307 (83.0)	63 (17.0)	2.16 (1.38–3.43, $p = 0.001$)	2.58 (1.60–4.24, $p < 0.001$)
	Libya	116 (91.3)	11 (8.7)	1.00 (0.47–1.99, $p = 0.997$)	1.13 (0.52–2.31, $p = 0.752$)
	Morocco	431 (88.0)	59 (12.0)	1.44 (0.92–2.29, $p = 0.114$)	1.74 (1.08–2.86, $p = 0.025$)
	Oman	1 (100.0)	0 (0.0)	0.00 (NA-Inf, $p = 0.983$)	–
	Palestine	337 (87.5)	48 (12.5)	1.50 (0.94–2.42, $p = 0.092$)	1.43 (0.87–2.38, $p = 0.163$)
	Saudi	347 (89.9)	39 (10.1)	1.18 (0.73–1.94, $p = 0.501$)	1.20 (0.69–2.11, $p = 0.513$)
	Sudan	377 (93.8)	25 (6.2)	0.70 (0.40–1.20, $p = 0.195$)	0.69 (0.39–1.22, $p = 0.201$)
	Syria	294 (87.5)	42 (12.5)	1.50 (0.93–2.46, $p = 0.099$)	1.44 (0.87–2.43, $p = 0.161$)
	Tunisia	3 (100.0)	0 (0.0)	0.00 (NA-Inf, $p = 0.971$)	0.00 (NA-Inf, $p = 0.971$)
	UAE	125 (82.8)	26 (17.2)	2.19 (1.25–3.82, $p = 0.006$)	2.64 (1.40–4.95, $p = 0.002$)
	Yemen	270 (95.7)	12 (4.3)	0.47 (0.23–0.90, $p = 0.029$)	0.42 (0.20–0.84, $p = 0.018$)
Geographic location	Rural	634 (87.4)	91 (12.6)	–	–
	Urban	3,717 (87.4)	537 (12.6)	1.01 (0.80–1.28, $p = 0.957$)	1.04 (0.81–1.35, $p = 0.756$)
Your highest educational level	Bachelors/Masters/Doctorate	2,564 (85.0)	452 (15.0)	–	–
	Diploma/Trade Qualification	793 (90.0)	88 (10.0)	0.63 (0.49–0.80, $p < 0.001$)	0.70 (0.54–0.90, $p = 0.006$)
	Primary	61 (96.8)	2 (3.2)	0.19 (0.03–0.60, $p = 0.019$)	0.11 (0.01–0.54, $p = 0.034$)
	Secondary/Intermediate/ Higher Secondary	933 (91.6)	86 (8.4)	0.52 (0.41–0.66, $p < 0.001$)	0.63 (0.48–0.82, $p = 0.001$)
Do you work in the medical field?	No	3,368 (90.1)	370 (9.9)	–	–
	Yes	983 (79.2)	258 (20.8)	2.39 (2.01–2.84, $p < 0.001$)	2.48 (2.03–3.02, $p < 0.001$)
Are you a sports coach?	No	3,916 (87.9)	538 (12.1)	–	–
	Yes	435 (82.9)	90 (17.1)	1.51 (1.17–1.91, $p = 0.001$)	2.10 (1.59–2.77, $p < 0.001$)
Where do you work?	Government Sector	808 (84.1)	153 (15.9)	–	–
	Housewife	174 (85.7)	29 (14.3)	0.88 (0.56–1.33, $p = 0.560$)	1.47 (0.89–2.38, $p = 0.124$)
	Private Sector	1,250 (88.8)	158 (11.2)	0.67 (0.53–0.85, $p = 0.001$)	0.75 (0.57–0.98, $p = 0.038$)
	Student	1,714 (87.4)	248 (12.6)	0.76 (0.62–0.95, $p = 0.016$)	1.11 (0.83–1.51, $p = 0.478$)
	Unemployed	405 (91.0)	40 (9.0)	0.52 (0.36–0.75, $p = 0.001$)	0.86 (0.57–1.29, $p = 0.473$)
Marital state	Divorced	71 (87.7)	10 (12.3)	–	–
	Married	1,196 (85.9)	197 (14.1)	1.17 (0.62–2.45, $p = 0.651$)	1.18 (0.59–2.65, $p = 0.656$)
	Single	3,054 (88.0)	417 (12.0)	0.97 (0.52–2.01, $p = 0.928$)	1.02 (0.50–2.32, $p = 0.958$)
	Widowed	30 (88.2)	4 (11.8)	0.95 (0.24–3.08, $p = 0.931$)	0.83 (0.17–3.21, $p = 0.803$)
Your monthly income in dollar	Mean (SD)	730.9 (1,473.2)	937.8 (1,720.2)	1.00 (1.00–1.00, $p = 0.002$)	1.00 (1.00–1.00, $p = 0.940$)
Weight before COVID-19 lockdown, kg	Mean (SD)	72.7 (17.9)	73.9 (16.7)	1.00 (1.00–1.01, $p = 0.112$)	0.99 (0.99–1.00, $p = 0.190$)
Weight during COVID-19 lockdown, kg	Mean (SD)	73.8 (20.9)	76.2 (26.2)	1.00 (1.00–1.01, $p = 0.019$)	1.01 (1.00–1.01, $p = 0.043$)
Height, cm.	Mean (SD)	168.0 (18.4)	168.5 (17.0)	1.00 (1.00–1.01, $p = 0.584$)	1.00 (0.99–1.01, $p = 0.816$)
Fat percentage before COVID-19 lockdown	Mean (SD)	19.0 (7.4)	19.9 (7.7)	1.02 (1.00–1.03, $p = 0.006$)	1.01 (0.99–1.04, $p = 0.223$)

(Continued)

TABLE 5 (Continued)

Demographics		Low	High	OR (univariable)	OR (multivariable)
Fat percentage during COVID−19 lockdown	Mean (SD)	19.9 (7.8)	20.7 (8.2)	1.01 (1.00–1.02, $p = 0.013$)	1.00 (0.98–1.02, $p = 0.696$)
Do you smoking?	No	3,361 (87.3)	490 (12.7)	–	–
	Yes	990 (87.8)	138 (12.2)	0.96 (0.78–1.17, $p = 0.663$)	1.01 (0.80–1.26, $p = 0.962$)
Do you use hormones and supplements?	Both of them	193 (92.8)	15 (7.2)	–	–
	Hormone only	32 (82.1)	7 (17.9)	2.81 (1.01–7.24, $p = 0.037$)	3.61 (1.22–9.98, $p = 0.015$)
	None of them	3,288 (86.6)	508 (13.4)	1.99 (1.21–3.54, $p = 0.012$)	1.84 (1.07–3.39, $p = 0.038$)
	Supplements only	838 (89.5)	98 (10.5)	1.50 (0.88–2.75, $p = 0.157$)	1.27 (0.72–2.40, $p = 0.430$)

compared to Algerian participants. While the adjusted odds of high knowledge level decreased significantly among participants from Yemen by 58% when compared to Algerian participants (OR = 0.42, 95%CI: (0.20–0.84, $p = 0.018$).

Furthermore, the adjusted odds of high level of knowledge decreased significantly among participants with diploma, or /trade qualification, primary and secondary, intermediate, or /higher secondary education by 30% (OR = 0.70, 95%CI: (0.54–0.90, $p = 0.006$), 89% (OR = 0.11, 95%CI: (0.01–0.54, $p = 0.034$) and 37% (OR = 0.63 (0.48–0.82, $p = 0.001$), respectively, when compared to participants with bachelors, masters or doctorate degree. Also, the adjusted odds of high level of knowledge increased significantly among participants working in the medical field by about 2.5 folds (OR = 2.48, 95%CI: (2.03–3.02, $p < 0.001$) when compared to participants who did not. The adjusted odds of level of high level of knowledge also increased significantly among sport coaches by about 2 folds (OR = 2.10, 95%CI: (1.59–2.77, $p < 0.001$) when compared to other participants. The adjusted odds of high level of knowledge level decreased significantly among participants working in private sector by nearly 25% (OR = 0.75, 95%CI: (0.57–0.98, $p = 0.038$) when compared to participants working in government sector.

Next, we found that the adjusted odds of high level of knowledge increased significantly by about 1% (OR = 1.01, 95%CI: (1.00–1.01, $p = 0.043$) for one unit increase in the weight of participants during COVID-19 lockdown. It also increased significantly among participants who used only anabolic hormones only and participants who did not use either anabolic hormones or nutritional supplements by 3.6 folds (OR = 3.61, 95%CI: (1.22–9.98, $p = 0.015$) and 84% (OR = 1.84, 95%CI: (1.07–3.39, $p = 0.038$) respectively, when compared to participants who used both (Table 5).

Saudi, Sudan, UAE and Yemen by about 31% (OR = 0.69, 95% CI: 0.49–0.97, $p = 0.033$), 37% (OR = 0.63, 95% CI: 0.43–0.92, $p = 0.016$), 40% (OR = 0.60, 95% CI: 0.41–0.87, $p = 0.008$), 54% (OR = 0.46, 95% CI: 0.31–0.68, $p < 0.001$), 42% (OR = 0.58, 95% CI: 0.32–0.98, $p = 0.050$) and 63% (OR = 0.37, 95% CI: 0.23–0.59, $p < 0.001$), respectively when compared to Algerian participants. Also, the odds of moderate level of knowledge decreased significantly among participants with diploma or trade qualification, primary and secondary, intermediate, higher secondary education by 19% (OR = 0.81, 95% CI: 0.66–0.98, $p = 0.034$), 78% (OR = 0.22, 95% CI: 0.05–0.59, $p = 0.010$) and 35% (OR = 0.65, 95% CI: 0.53–0.79, $p < 0.001$), respectively when compared to participants with bachelors, masters or doctorate degree.

Similar to the odds of high level of knowledge, the odds of moderate level of knowledge increased significantly among participants working in the medical field by about 2.6 folds (OR = 2.60, 95% CI: 2.24–3.03, $p < 0.001$) and participants working as sports coach by 71% (OR = 1.71, 95% CI: 1.38–2.09, $p < 0.001$) when compared other participants. who doesn't On the contrary, the odds of moderate level of knowledge decreased significantly among unemployed participants by about 48% (OR = 0.52, 95% CI: 0.36–0.73, $p < 0.001$) when compared to participants working in government sector. While the odds of moderate level of knowledge increased significantly by about 1% for each one unite increase in the participants height (OR = 1.01, 95%CI: (1.00–1.01), $p = 0.026$).

Notably, the odds of moderate level of knowledge level increased significantly among participants who used only nutritional supplements by nearly 58% (OR = 1.58, 95% CI: 1.07–2.40, $p = 0.025$) when compared to participants who used both anabolic hormones and nutritional supplements (Table 6).

Univariate logistic regression model for the association between demographics and moderate level of knowledge

The odds of moderate level of knowledge decreased significantly among participants from Morocco, Palestine,

Adjusted logistic regression model for the association between demographics and moderate level of knowledge

The adjusted odds of moderate level of knowledge decreased significantly among participants from Palestine, Sudan and

TABLE 6	Logistic regression models for the association between demographics and moderate level of knowledge.

Demographics		Low	Moderate	OR (univariable)	OR (multivariable)
Age	Mean (SD)	27.3 (8.7)	27.0 (8.1)	0.99 (0.99–1.00, $p = 0.252$)	1.01 (0.99–1.02, $p = 0.331$)
Sex	Female	1,789 (82.6)	377 (17.4)	-	-
	Male	2,562 (84.0)	489 (16.0)	0.91 (0.78–1.05, $p = 0.188$)	0.86 (0.70–1.06, $p = 0.166$)
Country of residence	Algeria	337 (80.0)	84 (20.0)	-	-
	Bahrain	136 (85.5)	23 (14.5)	0.68 (0.40–1.10, $p = 0.130$)	0.92 (0.53–1.55, $p = 0.762$)
	Egypt	357 (76.8)	108 (23.2)	1.21 (0.88–1.68, $p = 0.238$)	1.00 (0.70–1.42, $p = 0.989$)
	Iraq	331 (84.2)	62 (15.8)	0.75 (0.52–1.08, $p = 0.121$)	0.93 (0.62–1.38, $p = 0.716$)
	Jordan	236 (75.2)	78 (24.8)	1.33 (0.93–1.88, $p = 0.114$)	1.19 (0.81–1.74, $p = 0.380$)
	Qatar	43 (89.6)	5 (10.4)	0.47 (0.16–1.11, $p = 0.118$)	0.65 (0.21–1.62, $p = 0.395$)
	Kuwait	303 (83.2)	61 (16.8)	0.81 (0.56–1.16, $p = 0.251$)	1.03 (0.67–1.59, $p = 0.890$)
	Lebanon	307 (79.5)	79 (20.5)	1.03 (0.73–1.46, $p = 0.856$)	1.22 (0.83–1.78, $p = 0.310$)
	Libya	116 (82.3)	25 (17.7)	0.86 (0.52–1.40, $p = 0.564$)	0.84 (0.48–1.40, $p = 0.507$)
	Morocco	431 (85.3)	74 (14.7)	0.69 (0.49–0.97, $p = 0.033$)	0.89 (0.61–1.30, $p = 0.557$)
	Oman	1 (100.0)	0 (0.0)	0.00 (NA-Inf, $p = 0.982$)	-
	Palestine	337 (86.4)	53 (13.6)	0.63 (0.43–0.92, $p = 0.016$)	0.67 (0.45–1.00, $p = 0.049$)
	Saudi	347 (87.0)	52 (13.0)	0.60 (0.41–0.87, $p = 0.008$)	0.72 (0.46–1.11, $p = 0.141$)
	Sudan	377 (89.8)	43 (10.2)	0.46 (0.31–0.68, $p < 0.001$)	0.44 (0.29–0.66, $p < 0.001$)
	Syria	294 (79.5)	76 (20.5)	1.04 (0.73–1.47, $p = 0.837$)	1.00 (0.69–1.45, $p = 0.996$)
	Tunisia	3 (100.0)	0 (0.0)	0.00 (NA-Inf, $p = 0.969$)	0.00 (NA-Inf, $p = 0.954$)
	UAE	125 (87.4)	18 (12.6)	0.58 (0.32–0.98, $p = 0.050$)	0.75 (0.39–1.37, $p = 0.363$)
	Yemen	270 (91.5)	25 (8.5)	0.37 (0.23–0.59, $p < 0.001$)	0.40 (0.23–0.65, $p < 0.001$)
Geographic location	Rural	634 (85.1)	111 (14.9)	-	-
	Urban	3,717 (83.1)	755 (16.9)	1.16 (0.94–1.45, $p = 0.178$)	1.22 (0.97–1.55, $p = 0.093$)
Your highest educational level	Bachelors/Masters/Doctorate	2,564 (81.5)	581 (18.5)	-	-
	Diploma/Trade Qualification	793 (84.5)	145 (15.5)	0.81 (0.66–0.98, $p = 0.034$)	0.84 (0.68–1.04, $p = 0.119$)
	Primary	61 (95.3)	3 (4.7)	0.22 (0.05–0.59, $p = 0.010$)	0.36 (0.09–1.02, $p = 0.095$)
	Secondary/Intermediate/ Higher Secondary	933 (87.2)	137 (12.8)	0.65 (0.53–0.79, $p < 0.001$)	0.76 (0.60–0.95, $p = 0.016$)
Do you work in the medical field?	No	3,368 (87.3)	492 (12.7)	-	-
	Yes	983 (72.4)	374 (27.6)	2.60 (2.24–3.03, $p < 0.001$)	2.54 (2.14–3.01, $p < 0.001$)
Are you a sports coach?	No	3,916 (84.3)	728 (15.7)	-	-
	Yes	435 (75.9)	138 (24.1)	1.71 (1.38–2.09, $p < 0.001$)	1.91 (1.51–2.42, $p < 0.001$)
Where do you work?	Government Sector	808 (82.0)	177 (18.0)	-	-
	Housewife	174 (84.9)	31 (15.1)	0.81 (0.53–1.22, $p = 0.329$)	1.34 (0.83–2.12, $p = 0.221$)
	Private Sector	1,250 (83.9)	240 (16.1)	0.88 (0.71–1.09, $p = 0.226$)	0.92 (0.72–1.17, $p = 0.484$)
	Student	1,714 (82.2)	372 (17.8)	0.99 (0.81–1.21, $p = 0.927$)	1.17 (0.90–1.54, $p = 0.246$)
	Unemployed	405 (89.8)	46 (10.2)	0.52 (0.36–0.73, $p < 0.001$)	0.75 (0.51–1.09, $p = 0.142$)
Marital state	Divorced	71 (83.5)	14 (16.5)	-	-
	Married	1,196 (84.9)	213 (15.1)	0.90 (0.52–1.70, $p = 0.736$)	0.74 (0.41–1.43, $p = 0.344$)
	Single	3,054 (82.7)	637 (17.3)	1.06 (0.61–1.97, $p = 0.849$)	0.78 (0.43–1.52, $p = 0.445$)
	Widowed	30 (93.8)	2 (6.2)	0.34 (0.05–1.31, $p = 0.168$)	0.33 (0.05–1.33, $p = 0.165$)
Your monthly income in dollar	Mean (SD)	730.9 (1,473.2)	641.6 (1,261.3)	1.00 (1.00–1.00, $p = 0.100$)	1.00 (1.00–1.00, $p = 0.318$)
Weight before COVID-19 lockdown, Kg	Mean (SD)	72.7 (17.9)	73.9 (20.3)	1.00 (1.00–1.01, $p = 0.088$)	1.01 (1.00–1.01, $p = 0.071$)
Weight during COVID-19 lcokdown, Kg	Mean (SD)	73.8 (20.9)	74.3 (17.6)	1.00 (1.00–1.00, $p = 0.525$)	1.00 (0.99–1.00, $p = 0.330$)
Height, cm	Mean (SD)	168.0 (18.4)	169.5 (13.5)	1.01 (1.00–1.01, $p = 0.026$)	1.00 (1.00–1.01, $p = 0.207$)

(Continued)

TABLE 6 (Continued)

Demographics		Low	Moderate	OR (univariable)	OR (multivariable)
Fat percentage before COVID-19 lockdown	Mean (SD)	19.0 (7.4)	18.9 (7.3)	1.00 (0.99–1.01, $p = 0.648$)	1.00 (0.98–1.02, $p = 0.990$)
Fat percentage during COVID-19 lockdown	Mean (SD)	19.9 (7.8)	19.7 (7.6)	1.00 (0.99–1.01, $p = 0.436$)	1.00 (0.98–1.02, $p = 0.950$)
Do you smoke?	No	3,361 (83.1)	682 (16.9)	-	-
	Yes	990 (84.3)	184 (15.7)	0.92 (0.77–1.09, $p = 0.332$)	0.98 (0.79–1.19, $p = 0.810$)
Do you use hormones and supplements?	Both of them	193 (85.8)	32 (14.2)	-	-
	Hormones only	32 (84.2)	6 (15.8)	1.13 (0.40–2.76, $p = 0.799$)	1.86 (0.63–4.82, $p = 0.226$)
	None of them	3,288 (84.4)	608 (15.6)	1.12 (0.77–1.67, $p = 0.578$)	1.36 (0.89–2.15, $p = 0.170$)
	Supplements only	838 (79.2)	220 (20.8)	1.58 (1.07–2.40, $p = 0.025$)	1.91 (1.23–3.05, $p = 0.005$)

Yemen by about 33% (OR $= 0.67$, 95%CI: (0.45–1.00, $p = 0.049$), 56% (OR $= 0.44$, 95%CI: (0.29–0.66, $p < 0.001$) and 60% (OR $= 0.40$, 95%CI: (0.23–0.65, $p < 0.001$), respectively, compared to the Algerian participants. It decreased significantly among participants with secondary, intermediate, or higher secondary education by 24% (OR $= 0.76$, 95%CI: (0.60–0.95, $p = 0.016$) when compared to participants with bachelors, masters, or doctorate degree.

Again, the adjusted odds of moderate level of knowledge level increased significantly among participants working in the medical field by about 2.5 folds (OR $= 2.54$, 95%CI: (2.14–3.01, $p < 0.001$) and those working as sport coach by 91% (OR $= 1.91$, 95%CI: (1.51–2.42, $p < 0.001$) when compared to other participants. It also increased significantly among participants who used only nutritional supplements by 91% (OR $= 1.91$, 95%CI: (1.23–3.05, $p = 0.005$) in comparison to participants who used both anabolic hormones and nutritional supplements (Table 6).

Univariate logistic regression model for the association between demographics and high level of attitude

The odds of high level of attitude increased significantly among males by about 60% (OR $= 1.60$, 95% CI: 1.19–2.18, $p = 0.002$) compared to females. It increased significantly among participants from Jordan and Sudan by 2.2 folds (OR $= 2.15$, 95% CI: 1.07–4.47, $p = 0.034$) and 3.9 folds (OR $= 3.87$, 95% CI: 2.11–7.61, $p < 0.001$), respectively, compared to the Algerian participants. While the odds of high level of attitude level decreased significantly among the urban participants by 40% (OR $= 0.60$, 95% CI: 0.43–0.85, $p = 0.003$) compared to the rural participants. It also decreased significantly among participants with secondary, intermediate or higher secondary education by 33% (OR $= 0.67$, 95% CI: 0.44–0.98, $p = 0.048$) compared to participants with bachelors, masters or doctorate degree.

While the odds of high level of attitude increased significantly among participants working in the medical field by about 71% (OR $= 1.71$, 95% CI: 1.28–2.28, $p < 0.001$) compared to others. Also, it increased significantly among participants who used only nutritional supplements by 4 folds (OR $= 4.04$, 95% CI: 2.00–9.67, $p < 0.001$) compared to participants who used both anabolic hormones and nutritional supplements (Table 7).

Adjusted logistic regression model for the association between demographics and high level of attitude

The adjusted odds of high level of attitude increased significantly among participants from Kuwait and Sudan by 2.5 folds (OR $= 2.52$, 95%CI: (1.05–6.13, $p = 0.038$) and 4.8 folds (OR $= 4.78$, 95%CI: (2.46–9.94, $p < 0.001$), respectively, compared to Algerian participants; while it decreased significantly among the urban participants by 54% (OR $= 0.46$, 95%CI: (0.31–0.68, $p < 0.001$) in comparison to the rural participants.

Also, the adjusted odds of high level of attitude increased significantly among participants working in the medical field by about 98% (OR $= 1.98$, 95%CI: (1.40–2.79, $p < 0.001$) compared to other participants. It also increased significantly among participants who used only nutritional supplements by 5.2 folds (OR $= 5.21$, 95%CI: (2.37–13.80, $p < 0.001$) compared to participants who used both, anabolic hormones and nutritional supplements (Table 7).

Univariate logistic regression model for the association between demographics and moderate level of attitude

The odds of moderate level of attitude increased significantly by 1% for each one-year increase in participant's age (OR $=$

TABLE 7 Logistic regression models for the association between demographics and high level of attitude.

Demographics		Low	High	OR (univariable)	OR (multivariable)
Age	Mean (SD)	27.3 (8.6)	27.0 (7.4)	1.00 (0.98–1.01, $p = 0.619$)	0.98 (0.96–1.01, $p = 0.286$)
Sex	Female	2,085 (97.1)	63 (2.9)	-	-
	Male	2,933 (95.4)	142 (4.6)	1.60 (1.19–2.18, $p = 0.002$)	1.38 (0.91–2.11, $p = 0.137$)
Residence	Algeria	410 (96.9)	13 (3.1)	-	-
	Bahrain	151 (93.8)	10 (6.2)	2.09 (0.87–4.85, $p = 0.088$)	1.99 (0.78–4.97, $p = 0.141$)
	Egypt	459 (97.2)	13 (2.8)	0.89 (0.41–1.97, $p = 0.777$)	0.86 (0.36–2.03, $p = 0.723$)
	Iraq	384 (98.2)	7 (1.8)	0.57 (0.21–1.42, $p = 0.243$)	0.65 (0.21–1.77, $p = 0.410$)
	Jordan	308 (93.6)	21 (6.4)	2.15 (1.07–4.47, $p = 0.034$)	2.02 (0.95–4.47, $p = 0.074$)
	Qatar	52 (92.9)	4 (7.1)	2.43 (0.66–7.15, $p = 0.133$)	2.43 (0.61–8.06, $p = 0.168$)
	Kuwait	357 (96.0)	15 (4.0)	1.33 (0.62–2.86, $p = 0.466$)	2.52 (1.05–6.13, $p = 0.038$)
	Lebanon	384 (96.2)	15 (3.8)	1.23 (0.58–2.66, $p = 0.588$)	1.37 (0.60–3.19, $p = 0.452$)
	Libya	137 (95.8)	6 (4.2)	1.38 (0.48–3.57, $p = 0.521$)	1.20 (0.40–3.27, $p = 0.729$)
	Morocco	509 (98.1)	10 (1.9)	0.62 (0.26–1.42, $p = 0.261$)	0.88 (0.34–2.20, $p = 0.793$)
	Oman	1 (100.0)	0 (0.0)	0.00 (NA-Inf, $p = 0.985$)	-
	Palestine	378 (96.7)	13 (3.3)	1.08 (0.49–2.39, $p = 0.838$)	1.05 (0.45–2.45, $p = 0.911$)
	Saudi	363 (96.3)	14 (3.7)	1.22 (0.56–2.65, $p = 0.617$)	1.84 (0.78–4.39, $p = 0.165$)
	Sudan	350 (89.1)	43 (10.9)	3.87 (2.11–7.61, $p < 0.001$)	4.78 (2.46–9.94, $p < 0.001$)
	Syria	373 (97.9)	8 (2.1)	0.68 (0.27–1.62, $p = 0.390$)	0.70 (0.26–1.77, $p = 0.456$)
	Tunisia	1 (100.0)	0 (0.0)	0.00 (NA-Inf, $p = 0.985$)	0.00 (NA-Inf, $p = 0.997$)
	UAE	131 (94.9)	7 (5.1)	1.69 (0.62–4.20, $p = 0.276$)	1.60 (0.50–4.61, $p = 0.401$)
	Yemen	270 (97.8)	6 (2.2)	0.70 (0.24–1.80, $p = 0.477$)	0.99 (0.32–2.77, $p = 0.990$)
Geographic	Rural	702 (94.1)	44 (5.9)	-	-
	Urban	4,316 (96.4)	161 (3.6)	0.60 (0.43–0.85, $p = 0.003$)	0.46 (0.31–0.68, $p < 0.001$)
Your highest educational level	Bachelor/Master/PhD	3062 (95.7)	138 (4.3)	-	-
	Diploma/Trade Qualification	892 (96.0)	37 (4.0)	0.92 (0.63–1.32, $p = 0.661$)	1.12 (0.74–1.67, $p = 0.581$)
	Primary	66 (100.0)	0 (0.0)	0.00 (0.00–0.09, $p = 0.964$)	0.00 (0.00–0.00, $p = 0.976$)
	Secondary/Intermediate/ Higher Secondary	998 (97.1)	30 (2.9)	0.67 (0.44–0.98, $p = 0.048$)	1.01 (0.63–1.58, $p = 0.956$)
Do you work in the medical field?	No	3,672 (96.7)	126 (3.3)	-	-
	Yes	1,346 (94.5)	79 (5.5)	1.71 (1.28–2.28, $p < 0.001$)	1.98 (1.40–2.79, $p < 0.001$)
Are you a sports coach?	No	4,444 (96.1)	178 (3.9)	-	-
	Yes	574 (95.5)	27 (4.5)	1.17 (0.76–1.75, $p = 0.447$)	0.85 (0.52–1.35, $p = 0.499$)
Where do you work?	Government Sector	955 (95.7)	43 (4.3)	-	-
	Housewife	199 (96.6)	7 (3.4)	0.78 (0.32–1.65, $p = 0.552$)	1.22 (0.46–2.91, $p = 0.671$)
	Private Sector	1,415 (94.6)	80 (5.4)	1.26 (0.86–1.85, $p = 0.240$)	1.10 (0.71–1.73, $p = 0.673$)
	Student	2,029 (97.0)	63 (3.0)	0.69 (0.47–1.03, $p = 0.065$)	0.71 (0.42–1.20, $p = 0.197$)
	Unemployed	420 (97.2)	12 (2.8)	0.63 (0.32–1.18, $p = 0.170$)	0.72 (0.33–1.46, $p = 0.380$)
Marital state	Divorced	75 (97.4)	2 (2.6)	-	-
	Married	1,351 (95.4)	65 (4.6)	1.80 (0.55–11.12, $p = 0.417$)	1.45 (0.41–9.26, $p = 0.621$)
	Single	3,562 (96.3)	138 (3.7)	1.45 (0.45–8.89, $p = 0.605$)	0.87 (0.24–5.63, $p = 0.851$)
	Widowed	30 (100.0)	0 (0.0)	0.00 (NA-Inf, $p = 0.976$)	0.00 (NA-Inf, $p = 0.983$)
Your monthly income in dollar.	Mean (SD)	709.0 (1,434.5)	744.8 (1,360.5)	1.00 (1.00–1.00, $p = 0.727$)	1.00 (1.00–1.00, $p = 0.224$)
Weight.before.COVID.19.era.Kg.	Mean (SD)	73.1 (18.5)	74.9 (14.9)	1.00 (1.00–1.01, $p = 0.157$)	1.00 (0.99–1.01, $p = 0.752$)
Weight.during.COVID.19.era.Kg.	Mean (SD)	74.2 (20.7)	77.0 (37.5)	1.00 (1.00–1.01, $p = 0.073$)	1.00 (0.99–1.01, $p = 0.367$)
Height.cm.	Mean (SD)	168.3 (17.7)	170.6 (21.4)	1.01 (1.00–1.02, $p = 0.064$)	1.00 (0.99–1.01, $p = 0.440$)
Fat Percentage before COVID-19 lockdown	Mean (SD)	19.0 (7.4)	18.5 (6.9)	0.99 (0.97-1.01, $p = 0.280$)	1.00 (0.96-1.04, $p = 0.992$)

(Continued)

TABLE 7 (Continued)

Demographics		Low	High	OR (univariable)	OR (multivariable)
Fat Percentage during COVID-19 lockdown	Mean (SD)	19.9 (7.8)	19.3 (7.4)	0.99 (0.97–1.01, $p = 0.256$)	0.99 (0.96–1.02, $p = 0.594$)
Do you smoke?	No	3,890 (96.2)	153 (3.8)	-	-
	Yes	1,128 (95.6)	52 (4.4)	1.17 (0.84–1.61, $p = 0.333$)	0.95 (0.65–1.37, $p = 0.784$)
Do you use hormones and supplements?	Both of them	217 (96.9)	7 (3.1)	-	-
	Hormones only	43 (97.7)	1 (2.3)	0.72 (0.04–4.20, $p = 0.762$)	1.11 (0.06–7.13, $p = 0.925$)
	None of them	3,845 (98.0)	78 (2.0)	0.63 (0.31–1.51, $p = 0.247$)	0.77 (0.34–2.08, $p = 0.566$)
	Supplements only	913 (88.5)	119 (11.5)	4.04 (2.00–9.67, $p < 0.001$)	5.21 (2.37–13.80, $p < 0.001$)

1.01, 95% CI: 1.00–1.02, $p = 0.027$) while decreased significantly among males by 21% in comparison to females (OR = 0.79, 95% CI: 0.67–0.94, $p = 0.007$). Also, the odds of moderate level of attitude increased significantly among participants from Egypt, Jordan, Qatar, Kuwait, Lebanon, Palestine, Saudi, Sudan, Tunisia and UAE by about 99% (OR = 1.99, 95% CI: 1.28–3.17, $p = 0.003$), 2 folds (OR = 2.04, 95% CI: 1.27–3.34, $p = 0.004$), 2.6 folds (OR = 2.63, 95% CI: 1.16-5.53, $p = 0.014$), 2.3 folds (OR = 2.26, 95% CI: 1.43–3.62, $p = 0.001$), 78% (OR = 1.78, 95% CI: 1.12–2.88, $p = 0.017$), 70% (OR = 1.70, 95% CI: 1.06–2.77, $p = 0.030$), 2.3 folds (OR = 2.30, 95% CI: 1.46–3.68, $p < 0.001$), 2 folds (OR = 2.03, 95% CI: 1.28–3.29, $p = 0.003$), 27.3 folds (OR = 27.33, 95% CI: 2.55–598.16, $p = 0.008$) and 3.2 folds (OR = 3.23, 95% CI: 1.88–5.56, $p < 0.001$), respectively, compared to the Algerian participants.

Also, the odds of moderate level of attitude increased significantly among participants working in the medical field by about 20% (OR = 1.20, 95% CI: 1.00–1.44), $p = 0.049$) compared to others; but it decreased significantly among participants working in private sector by 26% (OR = 0.74, 95% CI: 0.58–0.94, $p = 0.014$) compared to participants working in government Sector and among married and single participants by 41% (OR = 0.59, 95% CI: 0.35–1.03, $p = 0.051$) and 52% (OR = 0.48, 95% CI: 0.29–0.83, $p = 0.006$), respectively, compared to divorced participants.

The odds of moderate level of attitude increased significantly among participants who did not use either anabolic hormones or nutritional supplements and participants who used only supplements by 70% (OR = 1.70, 95% CI: 1.05–2.96, $p = 0.045$) and 84% (OR = 1.84, 95% CI: 1.10–3.28, $p = 0.027$), respectively compared to participants who used both (Table 8).

Adjusted logistic regression model for the association between demographics and moderate level of attitude

The adjusted odds of moderate level of attitude increased significantly among participants from Egypt, Jordan, Qatar,

Kuwait, Lebanon, Saudi, Sudan, Tunisia and UAE by 74% (OR = 1.74, 95%CI: (1.10–2.82, $p = 0.021$), 91% (OR = 1.91, 95%CI: (1.15–3.19, $p = 0.013$), 2.3 folds (OR = 2.33, 95%CI: (1.00–5.08, $p = 0.040$), 95% (OR = 1.95, 95%CI: (1.18–3.29, $p = 0.010$), 77% (OR = 1.77, 95%CI: (1.09–2.94, $p = 0.024$), 84% (OR = 1.84, 95%CI: (1.12–3.08, $p = 0.018$), 2 folds (OR = 2.05, 95%CI: (1.27–3.36, $p = 0.004$), 25.7 folds (OR = 25.65, 95%CI: (2.36–565.82, $p = 0.009$), and 2.7 folds (OR = 2.68, 95%CI: (1.48–4.85, $p = 0.001$), respectively compared to the Algerian participants.

Moreover, the adjusted odds of moderate level of attitude level increased significantly among participants working in the medical field by 25% compared to others (OR = 1.25, 95%CI: (1.02–1.53, $p = 0.028$). It decreased significantly among married and single participants by 43% (OR = 0.57, 95%CI: (0.33–1.03, $p = 0.049$) and 53% (OR = 0.47, 95%CI: (0.27–0.87, $p = 0.012$), respectively compared to divorced participants (Table 8).

Univariate logistic regression model for the association between demographics and high level of practice

The odds of high level of practice increased significantly among males by about 3.4 folds compared to females (OR = 3.41, 95% CI: 1.60–8.40, $p = 0.003$). It increased significantly among sport coaches by about 8 folds compared to participants who are not sport coaches (OR = 8.03, 95% CI: 4.28–15.07, $p < 0.001$). The odds of high level of practice level increased significantly by about 1% for each one kg increase in participants' weight before (OR = 1.01, 95% CI: 1.00–1.02, $p = 0.001$) and during COVID-19 lockdown (OR = 1.01, 95% CI: 1.00–1.01, $p = 0.041$). Notably, the odds decreased significantly by 10% (OR = 0.90, 95% CI: 0.86–0.95, $p < 0.001$) and 9% (OR = 0.91, 95% CI: 0.87–0.95, $p < 0.001$) for each one unit increase in participants' fat percentage before and during COVD-19 lockdown, respectively. The odds also decreased significantly among participants who used only nutritional supplements by 82% compared to participants who used both anabolic

TABLE 8 Logistic regression models for the association between demographics and moderate level of attitude.

Demographics		Low	Moderate	OR (univariable)	OR (multivariable)
Age	Mean (SD)	27.3 (8.6)	28.1 (8.8)	1.01 (1.00–1.02, $p = 0.027$)	1.01 (0.99–1.02, $p = 0.466$)
Sex	Female	2,085 (87.6)	294 (12.4)	-	-
	Male	2,933 (89.9)	328 (10.1)	0.79 (0.67–0.94, $p = 0.007$)	0.93 (0.74–1.16, $p = 0.495$)
Country of residence	Algeria	410 (93.2)	30 (6.8)	-	-
	Bahrain	151 (89.3)	18 (10.7)	1.63 (0.87–2.98, $p = 0.119$)	1.52 (0.79–2.83, $p = 0.197$)
	Egypt	459 (87.3)	67 (12.7)	1.99 (1.28–3.17, $p = 0.003$)	1.74 (1.10–2.82, $p = 0.021$)
	Iraq	384 (92.1)	33 (7.9)	1.17 (0.70–1.97, $p = 0.539$)	1.12 (0.66–1.93, $p = 0.675$)
	Jordan	308 (87.0)	46 (13.0)	2.04 (1.27–3.34, $p = 0.004$)	1.91 (1.15–3.19, $p = 0.013$)
	Qatar	52 (83.9)	10 (16.1)	2.63 (1.16–5.53, $p = 0.014$)	2.33 (1.00–5.08, $p = 0.040$)
	Kuwait	357 (85.8)	59 (14.2)	2.26 (1.43–3.62, $p = 0.001$)	1.95 (1.18–3.29, $p = 0.010$)
	Lebanon	384 (88.5)	50 (11.5)	1.78 (1.12–2.88, $p = 0.017$)	1.77 (1.09–2.94, $p = 0.024$)
	Libya	137 (93.8)	9 (6.2)	0.90 (0.39–1.87, $p = 0.784$)	0.92 (0.40–1.94, $p = 0.835$)
	Morocco	509 (91.9)	45 (8.1)	1.21 (0.75–1.97, $p = 0.440$)	1.17 (0.72–1.94, $p = 0.534$)
	Oman	1 (100.0)	0 (0.0)	0.00 (NA-Inf, $p = 0.964$)	-
	Palestine	378 (88.9)	47 (11.1)	1.70 (1.06–2.77, $p = 0.030$)	1.51 (0.93–2.50, $p = 0.099$)
	Saudi	363 (85.6)	61 (14.4)	2.30 (1.46–3.68, $p < 0.001$)	1.84 (1.12–3.08, $p = 0.018$)
	Sudan	350 (87.1)	52 (12.9)	2.03 (1.28–3.29, $p = 0.003$)	2.05 (1.27–3.36, $p = 0.004$)
	Syria	373 (92.3)	31 (7.7)	1.14 (0.67–1.92, $p = 0.632$)	1.11 (0.65–1.90, $p = 0.709$)
	Tunisia	1 (33.3)	2 (66.7)	27.33 (2.55–598.16, $p = 0.008$)	25.65 (2.36–565.82, $p = 0.009$)
	UAE	131 (80.9)	31 (19.1)	3.23 (1.88–5.56, $p < 0.001$)	2.68 (1.48–4.85, $p = 0.001$)
	Yemen	270 (89.7)	31 (10.3)	1.57 (0.93–2.66, $p = 0.093$)	1.40 (0.80–2.45, $p = 0.233$)
Geographic location	Rural	702 (88.6)	90 (11.4)	-	-
	Urban	4,316 (89.0)	532 (11.0)	0.96 (0.76–1.23, $p = 0.745$)	0.90 (0.70–1.16, $p = 0.417$)
Your highest educational level	Bachelors/Masters/Doctorate	3,062 (88.5)	397 (11.5)	-	-
	Diploma/Trade Qualification	892 (90.2)	97 (9.8)	0.84 (0.66–1.06, $p = 0.141$)	0.95 (0.74–1.21, $p = 0.689$)
	Primary	66 (100.0)	0 (0.0)	0.00 (0.00–0.03, $p = 0.961$)	0.00 (0.00–0.00, $p = 0.943$)
	Secondary/Intermediate/ Higher Secondary	998 (88.6)	128 (11.4)	0.99 (0.80–1.22, $p = 0.920$)	1.10 (0.87–1.39, $p = 0.415$)
Do you work in the medical field?	No	3,672 (89.5)	432 (10.5)	-	-
	Yes	1346 (87.6)	190 (12.4)	1.20 (1.00–1.44, $p = 0.049$)	1.25 (1.02–1.53, $p = 0.028$)
Are you a sports coach?	No	4,444 (88.8)	560 (11.2)	-	-
	Yes	574 (90.3)	62 (9.7)	0.86 (0.64–1.12, $p = 0.274$)	1.05 (0.77–1.40, $p = 0.768$)
Where do you work?	Government Sector	955 (87.2)	140 (12.8)	-	-
	Housewife	199 (87.7)	28 (12.3)	0.96 (0.61–1.46, $p = 0.853$)	0.85 (0.52–1.37, $p = 0.522$)
	Private Sector	1,415 (90.2)	153 (9.8)	0.74 (0.58–0.94, $p = 0.014$)	0.81 (0.62–1.06, $p = 0.128$)
	Student	2,029 (89.3)	242 (10.7)	0.81 (0.65–1.02, $p = 0.068$)	0.97 (0.72–1.31, $p = 0.847$)
	Unemployed	420 (87.7)	59 (12.3)	0.96 (0.69–1.32, $p = 0.797$)	1.15 (0.79–1.65, $p = 0.460$)
Marital state	Divorced	75 (80.6)	18 (19.4)	-	-
	Married	1,351 (87.7)	190 (12.3)	0.59 (0.35–1.03, $p = 0.051$)	0.57 (0.33–1.03, $p = 0.049$)
	Single	3,562 (89.7)	408 (10.3)	0.48 (0.29–0.83, $p = 0.006$)	0.47 (0.27–0.87, $p = 0.012$)
	Widowed	30 (83.3)	6 (16.7)	0.83 (0.28–2.21, $p = 0.725$)	0.76 (0.24–2.15, $p = 0.621$)
Your monthly income in dollar	Mean (SD)	709.0 (1,434.5)	987.1 (1,777.1)	1.00 (1.00–1.00, $p < 0.001$)	1.00 (1.00–1.00, $p = 0.169$)
Weight before COVID-19 lockdown, Kg	Mean (SD)	73.1 (18.5)	72.2 (16.1)	1.00 (0.99–1.00, $p = 0.245$)	1.00 (0.99–1.01, $p = 0.500$)
Weight during COVID-19 lockdown, Kg	Mean (SD)	74.2 (20.7)	73.0 (16.0)	1.00 (0.99–1.00, $p = 0.181$)	1.00 (0.99–1.01, $p = 0.784$)
Height, cm	Mean (SD)	168.3 (17.7)	167.6 (16.0)	1.00 (0.99–1.00, $p = 0.343$)	1.00 (1.00–1.01, $p = 0.822$)

(Continued)

TABLE 8 (Continued)

Demographics		Low	Moderate	OR (univariable)	OR (multivariable)
Fat percentage before COVID-19 lcokdown	Mean (SD)	19.0 (7.4)	19.4 (7.5)	1.01 (1.00–1.02, $p = 0.207$)	1.01 (0.98–1.03, $p = 0.654$)
Fat percentage during COVID-19 lockdown	Mean (SD)	19.9 (7.8)	20.3 (8.0)	1.01 (1.00–1.02, $p = 0.283$)	1.00 (0.98–1.02, $p = 0.850$)
Do you smoke?	No	3,890 (88.8)	490 (11.2)	-	-
	Yes	1,128 (89.5)	132 (10.5)	0.93 (0.76–1.14, $p = 0.478$)	1.00 (0.79–1.25, $p = 0.974$)
Do you use hormones and supplements?	Both of them	217 (93.1)	16 (6.9)	-	-
	Hormones only	43 (97.7)	1 (2.3)	0.32 (0.02–1.61, $p = 0.269$)	0.30 (0.02–1.60, $p = 0.259$)
	None of them	3,845 (88.9)	481 (11.1)	1.70 (1.05–2.96, $p = 0.045$)	1.53 (0.90–2.78, $p = 0.139$)
	Supplements only	913 (88.0)	124 (12.0)	1.84 (1.10–3.28, $p = 0.027$)	1.72 (1.00–3.18, $p = 0.065$)

hormones and nutritional supplements (OR = 0.18, 95% CI: 0.10–0.35, $p < 0.001$) (Table 9).

Adjusted logistic regression model for the association between demographics and the high level of practice

The adjusted odds of high level of practice increased significantly among sport coaches by about 3 folds compared to other participants (OR = 3.00, 95%CI: (1.34–6.74, $p = 0.007$); while the adjusted odds of high practice level decreased significantly among smokers by about 65% compared to non-smokers (OR = 0.35, 95%CI: (0.12–0.89, $p = 0.036$). It also decreased significantly among participants who used only supplements and participants who neither used hormones nor supplements by 79% (OR = 0.21, 95%CI: (0.09–0.47, $p < 0.001$) and 100% (OR = 0.00, 95%CI: (0.00–0.03, $p < 0.001$), respectively compared to participants who used both anabolic hormones and nutritional supplements (Table 9).

The proportion of participants who were advised to use anabolic hormones and nutritional supplements by doctor, nutritionist, pharmacist, trainer, internet, self and miscellaneous was 2.1, 2.3, 0.75, 5.1, 4.2, 0.68, and 4.7%, respectively. The source of information for the used anabolic hormones and nutritional supplements was trainer (11.7%), doctor (21.4%), friends (39.2%), and internet (64%). The reason for using these hormones and supplements included body building (8.2%), performance improvement (6.1%), protection from disease (2.9%), and weight loss (2.4%). About 31.6% of the participants thought that anabolic hormones and nutritional supplements help to win championships, 66.3% thought that these help them to look better, and almost all the participants thought that these help to make them athletic and strong.

Analysis of this survey revealed that 14.3% of participants used proteins, 1.3% used energy bars, 6.9% used vitamins, and 1.1% used sport drinks before COVID-19 lockdown. During the

COVID-19 lockdown, 6.9% used proteins, 1.2% used energy bar (carbohydrate), 7.2% used vitamins and 0.9% used sport drinks. Interestingly, before COVID-19 lockdown, 6.5% of participants used anabolic steroids, 0.5% used insulin, 0.75% used growth hormone (GH) and 0.4% used cortisol and during the lockdown, 4.1% of the study population used anabolic steroids, 0.4% used insulin, 0.5% used GH and 0.1% used cortisol. Tablets and injects were used by 1.6 and 1.2% of participants for administration of hormones, 1.4% used both and 8.1% did not use either of the two. Before COVID-19 lockdown, the anabolic hormones and nutritional supplements were sourced from gym trainer (3.2%), online stores (3.4%), and pharmacy (5.7%); during the lockdown, these products were sourced by gym trainer (2.9%), online stores (3.9%), and pharmacy (5.5%). Stopping the use of anabolic hormones led to "fluctuations in mood and depression" (1.6%), anorexia (0.8%), anxiety and insomnia (1.1%), "decrease in fitness" (0.9%), muscle weakness (1.8%), "desire to return to hormones again" (1%). No symptoms were reported in 1.5% of participants, 7.6% reported not using the anabolic hormones and 0.7% reported that they never stopped using hormones (Supplementary Table S1).

McNemar's test was used for comparative analysis between types of supplements used before and during COVID-19 lockdown. It showed a statistically significant decrease in consumption of proteins, carbohydrates and sport drinks during COVID-19 lockdown and a statistically significant increase in consumption of vitamins during COVID-19 lockdown compared to that prior to the COVID-19 lockdown ($p < 0.001$) (Supplementary Table S2).

Supplementary Table S3 depicts a statistically significant decrease in the use of all types of hormones during COVID-19 lockdown compared to that prior to the COVID-19 lockdown ($p < 0.001$). Further, procurement of these hormones and supplements showed a statistically significant decrease from gym trainer or pharmacy and statistically significant increase from online sources during COVID-19 lockdown compared to the before lockdown time ($p < 0.001$) (Supplementary Table S4).

TABLE 9 Logistic regression models for the association between demographics and high level of practice.

Demographics		Low	High	OR (univariable)	OR (multivariable)
Age	Mean (SD)	27.4 (8.6)	28.1 (6.2)	1.01 (0.97–1.04, $p = 0.612$)	1.04 (0.97–1.12, $p = 0.241$)
Sex	Female	2,435 (99.7)	7 (0.3)	-	-
	Male	3,370 (99.0)	33 (1.0)	3.41 (1.60–8.40, $p = 0.003$)	0.75 (0.23–2.65, $p = 0.631$)
Country of residence	Algeria	447 (98.7)	6 (1.3)	-	-
	Bahrain	179 (100.0)	0 (0.0)	0.00 (NA-Inf, $p = 0.990$)	0.00 (0.00-Inf, $p = 0.993$)
	Egypt	538 (99.8)	1 (0.2)	0.14 (0.01–0.81, $p = 0.068$)	0.45 (0.02–3.94, $p = 0.507$)
	Iraq	422 (99.5)	2 (0.5)	0.35 (0.05–1.54, $p = 0.204$)	0.70 (0.08–5.24, $p = 0.728$)
	Jordan	365 (97.3)	10 (2.7)	2.04 (0.75–6.05, $p = 0.171$)	3.20 (0.81–16.08, $p = 0.116$)
	Qatar	64 (97.0)	2 (3.0)	2.33 (0.34–10.35, $p = 0.307$)	5.91 (0.57–51.32, $p = 0.109$)
	Kuwait	428 (99.3)	3 (0.7)	0.52 (0.11–1.99, $p = 0.360$)	0.93 (0.10–7.45, $p = 0.947$)
	Lebanon	448 (99.8)	1 (0.2)	0.17 (0.01–0.98, $p = 0.097$)	1.15 (0.05–10.20, $p = 0.907$)
	Libya	147 (96.7)	5 (3.3)	2.53 (0.72–8.53, $p = 0.129$)	2.54 (0.51–14.40, $p = 0.261$)
	Morocco	563 (99.8)	1 (0.2)	0.13 (0.01–0.78, $p = 0.062$)	0.56 (0.03–5.06, $p = 0.634$)
	Oman	1 (100.0)	0 (0.0)	0.00 (NA-Inf, $p = 0.999$)	-
	Palestine	438 (100.0)	0 (0.0)	0.00 (NA-Inf, $p = 0.985$)	0.00 (0.00-Inf, $p = 0.990$)
	Saudi	437 (99.8)	1 (0.2)	0.17 (0.01–1.00, $p = 0.102$)	0.37 (0.01–4.02, $p = 0.455$)
	Sudan	440 (98.9)	5 (1.1)	0.85 (0.24–2.83, $p = 0.785$)	3.41 (0.73–18.77, $p = 0.126$)
	Syria	411 (99.8)	1 (0.2)	0.18 (0.01–1.07, $p = 0.115$)	0.72 (0.03–6.50, $p = 0.786$)
	Tunisia	3 (100.0)	0 (0.0)	0.00 (NA-Inf, $p = 0.999$)	0.00 (0.00-Inf, $p = 0.999$)
	UAE	169 (100.0)	0 (0.0)	0.00 (NA-Inf, $p = 0.990$)	0.00 (0.00-Inf, $p = 0.994$)
	Yemen	305 (99.3)	2 (0.7)	0.49 (0.07–2.14, $p = 0.382$)	2.71 (0.30–20.20, $p = 0.331$)
Geographic location	Rural	834 (99.8)	2 (0.2)	-	-
	Urban	4,971 (99.2)	38 (0.8)	3.19 (0.98–19.62, $p = 0.110$)	1.00 (0.25–6.76, $p = 0.997$)
Your highest educational level	Bachelor/Master/PhD	3,571 (99.3)	26 (0.7)	-	-
	Diploma/Trade Qualification	1,015 (98.9)	11 (1.1)	1.49 (0.70–2.95, $p = 0.271$)	1.46 (0.58–3.47, $p = 0.400$)
	Primary	66 (100.0)	0 (0.0)	0.00 (NA-Inf, $p = 0.986$)	0.00 (0.00-Inf, $p = 0.996$)
	Secondary/Intermediate/ Higher Secondary	1,153 (99.7)	3 (0.3)	0.36 (0.09–1.02, $p = 0.092$)	0.53 (0.11–1.74, $p = 0.341$)
Do you work in the medical field?	No	4,199 (99.3)	31 (0.7)	-	-
	Yes	1,606 (99.4)	9 (0.6)	0.76 (0.34–1.53, $p = 0.468$)	0.90 (0.34–2.17, $p = 0.820$)
Are you a sports coach?	No	5,162 (99.6)	20 (0.4)	-	-
	Yes	643 (97.0)	20 (3.0)	8.03 (4.28–15.07, $p < 0.001$)	3.00 (1.34–6.74, $p = 0.007$)
Where do you work?	Government Sector	1,131 (99.4)	7 (0.6)	-	-
	Housewife	233 (99.6)	1 (0.4)	0.69 (0.04–3.92, $p = 0.733$)	2.56 (0.11–25.83, $p = 0.468$)
	Private Sector	1,627 (98.7)	21 (1.3)	2.09 (0.93–5.31, $p = 0.093$)	0.92 (0.32–2.82, $p = 0.871$)
	Student	2,324 (99.6)	10 (0.4)	0.70 (0.27–1.92, $p = 0.462$)	1.25 (0.33–4.99, $p = 0.742$)
	Unemployed	490 (99.8)	1 (0.2)	0.33 (0.02–1.86, $p = 0.300$)	0.47 (0.02–3.68, $p = 0.534$)
Marital state	Divorced	94 (98.9)	1 (1.1)	-	-
	Married	1,596 (99.4)	10 (0.6)	0.59 (0.11–10.87, $p = 0.616$)	1.37 (0.16–32.56, $p = 0.800$)
	Single	4,079 (99.3)	29 (0.7)	0.67 (0.14–11.97, $p = 0.693$)	2.54 (0.28–63.06, $p = 0.470$)
	Widowed	36 (100.0)	0 (0.0)	0.00 (NA-Inf, $p = 0.984$)	0.00 (0.00-Inf, $p = 0.997$)
Your monthly income in dollar	Mean (SD)	738.0 (1,473.5)	1,056.4 (1,636.1)	1.00 (1.00–1.00, $p = 0.202$)	1.00 (1.00–1.00, $p = 0.436$)
Weight before COVID-19 lockdown, Kg	Mean (SD)	73.0 (18.1)	84.3 (21.3)	1.01 (1.00–1.02, $p = 0.001$)	1.01 (0.99–1.02, $p = 0.108$)
Weight during COVID-19 lockdown, Kg	Mean (SD)	74.1 (21.2)	81.8 (14.3)	1.01 (1.00–1.01, $p = 0.041$)	1.00 (0.98–1.01, $p = 0.901$)
Height, cm	Mean (SD)	168.3 (17.6)	172.5 (17.7)	1.03 (1.00–1.06, $p = 0.090$)	1.00 (0.99–1.03, $p = 0.814$)

(Continued)

TABLE 9 (Continued)

Demographics		Low	High	OR (univariable)	OR (multivariable)
Fat percentage before COVID-19 lockdown	Mean (SD)	19.1 (7.4)	14.3 (7.3)	0.90 (0.86–0.95, $p < 0.001$)	0.99 (0.90–1.08, $p = 0.798$)
Fat percentage during COVID-19 lockdown	Mean (SD)	20.0 (7.8)	15.2 (8.3)	0.91 (0.87–0.95, $p < 0.001$)	0.97 (0.89–1.05, $p = 0.445$)
Do you smoke?	No	4,500 (99.3)	33 (0.7)	-	-
	Yes	1,305 (99.5)	7 (0.5)	0.73 (0.30–1.56, $p = 0.454$)	0.35 (0.12–0.89, $p = 0.036$)
Do you use hormones and supplements?	Both of them	220 (91.7)	20 (8.3)	-	-
	Hormones only	45 (100.0)	0 (0.0)	0.00 (NA-Inf, $p = 0.987$)	0.00 (0.00-Inf, $p = 0.996$)
	None of them	4,403 (100.0)	1 (0.0)	0.00 (0.00–0.01, $p < 0.001$)	0.00 (0.00–0.03, $p < 0.001$)
	Supplements only	1,137 (98.4)	19 (1.6)	0.18 (0.10–0.35, $p < 0.001$)	0.21 (0.09–0.47, $p < 0.001$)

Discussion

This study reports knowledge, practice, and attitude toward anabolic hormones and nutritional supplements among people who exercise in Arab countries. This is the first report comparing people's practice before and during the COVID-19 lockdown. In this study, the mean age of participants was 27.4 (SD = 8.6). Studies from different countries reported that their participants were also of the similar age group which showing that exercising and using hormones and supplements are more common in the young age (13, 14, 24, 25). Among 5845 participants, we found that 19.8% of participants were using nutritional supplements alone, 0.8% of participants were using anabolic hormones alone, and 4.1% were using both the products at the same time. Different studies from various Arab countries showed a high prevalence of anabolic hormones users. In the UAE and Kuwait, the prevalence of anabolic hormones users was about 22% (14, 26); in Jordan it was 26% (27); in Iran, it was13% (28); and 9.8% in Saudi Arabia (23). The possible causes for these variations could be the difference in sample sizes and under reporting of self-reported drug abuse where participants feel embarrassed to admit their use. Regarding the use of nutritional supplements, studies reported that the prevalence was 36 % in Lebanon (29), and 66.7% in Iran (30). In this study, the main aims of using these hormones ad supplements were bodybuilding and improving performance which is similar to the one conducted in 2021 in Iraq (24). Most of the study population used proteins (14.3%) and vitamins (6.9%) as sources of nutritional supplements and anabolic steroids (6.5%) as sources of hormones. This was comparable with the data reported by studies conducted in Saudi Arabia (2020) where the most commonly used nutritional supplement was proteins and the most commonly used hormone was steroids. However, another study conducted in 2018 in Kuwait reported growth hormone (79.4%) to be the most commonly used anabolic hormone which indicates

that substance abuse is not limited to steroids (13, 23, 25).

Regarding knowledge, more than 70% of the participants had low knowledge about the harmful effects of unsupervised use of anabolic hormones and nutritional supplements. This was reported in other studies as well (14, 23). Participants from Egypt, Jordan, Qatar, Kuwait, Lebanon, and UAE showed significantly high level of knowledge compared to the participants from Algeria. Also, participants who work in the medical field or as sports coaches showed significantly increased level of knowledge level compared with other participants. This finding is logical and can be explained that the nature of those jobs can help participants gain more knowledge about the effect of using these hormones and supplements. More than half of the participants (64%) got their information from the internet, followed by their friends (39%) and doctors (21.4%) being their source of information. A study conducted in Saudi Arabia (2020) reported similar results but with a much less percentage; 13.6% considered the online source as the main source of information while 3.8% considered physicians as the main source (25). This finding indicates the importance of a carefully organized online campaign to increase awareness about the abuse of hormones and supplements.

Next, we observed high level of practice increased significantly among males compared to females. This may be attributed to cultural reasons as anabolic hormones are known to the public for their use among males to build their muscles. About 100% of the participants believed that hormones and supplements can make them athletic and strong and nearly 66% of the participants believed that these hormones and supplements help them to look better. Similar beliefs were reported by another study that hormones and supplements can increase muscle size and strength (14). In our report, we found pharmacy to be the main source for hormones and supplements which is different from the other reports where gym trainers were the main providers (26, 27). This could be because of

the regulations forbidding the purchasing or selling anabolic hormones from sources other than pharmacies. Trainers were the most common people to advise the participants to use hormones and supplements. The same results were reported in study conducted in 2008 in the UAE (14). This is because trainers at gyms, without paying attention to the adverse effects of these substances, want their trainees to improve rapidly to gain more reputations.

Regarding the difference in habits of using vitamins between before and during COVID-19 lockdown, it was found that the usage significantly increased during the COVID-19 lock down compared to before the lockdown. The same finding was reported by a study conducted in Saudi Arabia (31). The main reason behind that might be the media that frequently advised the public to take vitamins to protect against the corona virus and to help in the treatment in case of being infected. The source from which the participants bought hormones and supplements during the COVID-19 lock down has changed significantly toward the online source. During the COVID-19, there has been a complete lockdown which led to online shopping being one of the alternative sources for buying these substances in most cases. As a result, the danger of unsupervised practice or non-prescribed substances is expected to be increased during this period.

Our findings encourage the need for educational programs through social media and mass media to address the potential effect of these substances on health. Participants who use these drugs achieve their goals by gaining weight and improving their body image which makes it difficult to change their behaviors. That is why, it is necessary to offer training courses and use a comprehensive approach to modify the public belief (13). Another possible solution can be directed toward health care providers by providing courses for them to have more knowledge to advise their patients. Also, sports coaches need to be educated about the effects of hormones and supplements as they represent a powerful reason for many participants to start using these drugs (24). This current study has some limitations. First, hormones and supplements were included together in the questions related to knowledge, practice, and attitude to overcome the participants' fear to answer questions related to anabolic hormones. Second, the survey was self-reported which might lead to some degree of reporting bias. Third, this survey did not investigate the dose of these substances. At last, the study cannot report the cause-effect relationship.

Conclusion

This cross-sectional study reported the knowledge, practice, and attitude toward the use of anabolic hormones and nutritional supplements in the MENA region. The level of knowledge was low among most of the participants. High level of knowledge was reported among participants in the medical field and participants who were sports coaches. The level of practice was high among male participants and sports coaches. Proteins and steroids were the most used supplements and hormones respectively. The source of information was mainly internet and the main source of procuring the substances was the pharmacy. During the COVID-19 lockdown, there has been an increase in the use of vitamins. Campaigns through social media should be done to aware the population about the harmful effect of these substances. Also, courses should be available for health care providers and sports coaches.

Data availability statement

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

Ethics statement

The studies involving human participants were reviewed and approved by Institutional Review Board Committee (IRB) at the Sahel General Hospital, Lebanon. The patients/participants provided their written informed consent to participate in this study.

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NE questionnaire design, web-survey design, supervised the data collection process, and checked writing. SN researched literature, questionnaire design, web survey design, coordinate and monitor the data collection process with collaborators, and wrote the first draft of the manuscript. RS interpret data, organizing and data arrangement, coded data, involved in statistical analysis, designed figures, and checked writing. RM manuscript editing. NH supervised all steps, checked writing, and approved methodology. The EARG Group collected the data. All authors have seen and approved the final version of the manuscript.

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Conflict of interest

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

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpubh.2022.1018757/full#supplementary-material

References

1. *Statement on the Second Meeting of the International Health Regulations (2005) Emergency Committee regarding the Outbreak of Novel Coronavirus (2019-nCoV)*. (2020). Available online at: https://www.who.int/news/item/30-01-2020-statement-on-the-second-meeting-of-the-international-health-regulations-(2005)-emergency-committee-regarding-the-outbreak-of-novel-coronavirus-(2019-ncov) (accessed February 2, 2021).

2. *WHO Director-General's Opening Remarks at the Media Briefing on COVID-19 - 11 March 2020*. (2020). Available online at: https://www.who.int/director-general/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19-$-$11-march-2020 (accessed February 2, 2021).

3. Shigemura J, Ursano R. *Public Responses to the Novel 2019 Coronavirus (2019-nCoV) in Japan: Mental Health Consequences and Target Populations*. ncbi.nlm.nih.gov. (2020). Available online at: https://www.ncbi.nlm.nih.gov/pmc/articles/pmc7168047/ doi: 10.1111/pcn.12988 (accessed February 2, 2021).

4. *Coronavirus Disease (COVID-19) Weekly Epidemiological Update Global Epidemiological Situation*.

5. Wilder-Smith A. Medicine DF-J of travel. *Isolation, Quarantine, Social Distancing and Community Containment: Pivotal Role for Old-style Public Health Measures in the Novel Coronavirus (2019-nCoV) Outbreak*. academic.oup.com. (2020). Available online at: https://academic.oup.com/jtm/article-abstract/27/2/taaa020/5735321 (accessed Febryary 2, 2021)

6. *COVID-19 Crisis Response in MENA Countries - OECD*. (2020). Available online at: https://read.oecd-ilibrary.org/view/?ref=129_129919-4li7bq8asv&title=COVID-19-Crisis-Response-in-MENA-Countries (accessed February 2, 2021).

7. Ingram J, Maciejewski G, Hand CJ. Changes in diet, sleep, and physical activity are associated with differences in negative mood during COVID-19 lockdown. *Front Psychol*. (2020) 11:1–9. doi: 10.3389/fpsyg.2020.588604

8. Koh D. COVID-19 lockdowns throughout the world. *Occupational Medicine*. Oxford University Press. (2020). p. 322.

9. Khojah YY. Prevalence of Using Hormones and Nutritional Supplements among Gym's Trainee in Saudi Arabia. *Egypt J Hosp Med*. (2018) 73:6724–33. doi: 10.21608/ejhm.2018.16174

10. *Anabolism - Definition & Examples of Anabolic Pathways | Biology*. (2019). Available online at: https://biologydictionary.net/anabolism/ (accessed February 2, 2021).

11. Yarasheski KE, Zachwieja JJ, Bier DM. Acute effects of resistance exercise on muscle protein synthesis rate in young and elderly men and women (American Journal of Physiology) (August 1993) 265 (E210-E214)). *Am J Physiol Endocrinol Metab*. (1993) 265:210–014. doi: 10.1152/ajpendo.1993.265.2.E210

12. Campbell WW, Leidy HJ. Dietary protein and resistance training effects on muscle and body composition in older persons. *J Am Coll Nutr*. (2007) 26:696S–703S. doi: 10.1080/07315724.2007.10719650

13. Allafi A, Almansour F, Alreshoud A. The use of anabolic hormones by Kuwaiti males. *Sci Sport*. (2019) 34:40–4. doi: 10.1016/j.scispo.2018.08.003

14. Al-Falasi O, Al-Dahmani K, Al-Eisaei K, Al-Ameri S, Al-Maskari F, Nagelkerke N, et al. Knowledge, attitude and practice of anabolic steroids use among gym users in Al-Ain District, United Arab Emirates. *Open Sport Med J*. (2009) 2:75–81. doi: 10.2174/1874387000802010075

15. Tian HH, Ong WS, Tan CL. Nutritional supplement use among university athletes in Singapore. *Singapore Med J*. (2009) 50:165–72.

16. Morrison LJ, Gizis F, Shorter B. Prevalent use of dietary supplements among people who exercise at a commercial gym. *Int J Sport Nutr Exerc Metab*. (2004) 14:481–92. doi: 10.1123/ijsnem.14.4.481

17. Pope HG, Khalsa JH, Bhasin S. Body image disorders and abuse of anabolic-androgenic steroids among men. *JAMA*. (2017) 317:23–4. doi: 10.1001/jama.2016.17441

18. Christou MA, Christou PA, Markozannes G, Tsatsoulis A, Mastorakos G, Tigas S. Effects of anabolic androgenic steroids on the reproductive system of athletes and recreational users: a systematic review and meta-analysis. *Sport Med*. (2017) 47:1869–83. doi: 10.1007/s40279-017-0709-z

19. Lindqvist Bagge AS, Rosén T, Fahlke C, Ehrnborg C, Eriksson BO, Moberg T, et al. Somatic effects of AAS abuse: A 30-years follow-up study of male former power sports athletes. *J Sci Med Sport*. (2017) 20:814–8. doi: 10.1016/j.jsams.2017.03.008

20. Congeni J, Miller S. Supplements and drugs used to enhance athletic performance. *Pediatr Clin North Am*. (2002) 49:435–61. doi: 10.1016/S0031-3955(01)00013-X

21. Charan J, Biswas T. Review article how to calculate sample size for different study designs in medical research? *Indian J Psychol Med*. (2013) 35:121–6. doi: 10.4103/0253-7176.116232

22. Arkin H. *Handbook of Sampling for Auditing and Accounting*. 3rd ed. Sioux Falls, SD: McGraw-Hill. (1984). p. 21.

23. Althobiti S, Alqurashi N, Alotaibi A, Alharthi T, Alswat K. Prevalence, attitude, knowledge, and practice of Anabolic Androgenic Steroid (AAS) use among gym participants. *Mater Socio Medica*. (2018) 30:49. doi: 10.5455/msm.2018.30.49-52

24. *(16) (PDF) Use of Nutritional Supplements Among Gym Clubs Participants in Sulaymaniyah City, Kurdistan Region of Iraq*. Available online at: https://www.researchgate.net/publication/354965275_Use_of_Nutritional_Supplements_Among_Gym_Clubs_Participants_in_Sulaymaniyah_City_Kurdistan_Region_of_Iraq (accessed April 2, 2022).

25. Abdelbaky A, Althubaiti AA, Aloufi BA. Evaluation of knowledge, attitude and use of dietary supplement and hormones among male gym attendees in Taif City, Saudi Arabia. *World Fam Med Journal/Middle East J Fam Med*. (2020) 18:176–86. doi: 10.5742/MEWFM.2020.93745

26. Alsaeed I, Alabkal JR. Usage and perceptions of anabolic-androgenic steroids among male fitness centre attendees in Kuwait - a cross-sectional study. *Subst Abus Treat Prev Policy*. (2015) 10:1–6. doi: 10.1186/s13011-015-0030-5

27. Tahtamouni LH, Mustafa NH, Alfaouri AA, Hassan IM, Abdalla Y, Yasin SR. *Prevalence and Risk Factors for Anabolic-Androgenic Steroid Abuse Among Jordanian Collegiate Students and Athletes*. (2008). Available online at: https://academic.oup.com/eurpub/article/18/6/661/576871 (accessed April 02, 2022).

28. Fayyazi Bordbar MR, Abdollahian E, Samadi R, Dolatabadi H. Frequency of use, awareness, and attitudes toward side effects of anabolic-androgenic steroids consumption among male medical students in Iran. *Subst Use Misuse.* (2014) 49:1751–8. doi: 10.3109/10826084.2014.8 80175

29. Aljaloud SO, Ibrahim SA. Use of dietary supplements among professional athletes in Saudi Arabia. *J Nutr Metab.* (2013) 2013. doi: 10.1155/2013/245349

30. Saeedi P, Mohd Nasir MT, Hazizi AS, Vafa MR, Foroushani AR. Nutritional supplement use among fitness club participants in Tehran, Iran. *Appetite.* 2013 60:20–6. doi: 10.1016/j.appet.2012.09.011

31. Alfawaz HA, Khan N, Aljumah GA, Hussain SD, Al-Daghri NM. Dietary intake and supplement use among saudi residents during covid-19 lockdown. *Int J Environ Res Public Health.* (2021) 18:1–13. doi: 10.3390/ijerph181 26435

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People's interest in brain health testing: Findings from an international, online cross-sectional survey

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Brain health entails mental wellbeing and cognitive health in the absence of brain disorders. The past decade has seen an explosion of tests, cognitive and biological, to predict various brain conditions, such as Alzheimer's Disease. In line with these current developments, we investigated people's willingness and reasons to—or not to—take a hypothetical brain health test to learn about risk of developing a brain disease, in a cross-sectional multilanguage online survey. The survey was part of the Global Brain Health Survey, open to the public from 4th June 2019 to 31st August 2020. Respondents were largely recruited via European brain councils and research organizations. 27,590 people responded aged 18 years or older and were predominantly women (71%), middle-aged or older (>40 years; 83%), and highly educated (69%). Responses were analyzed to explore the relationship between demographic variables and responses.

Results: We found high public interest in brain health testing: over 91% would definitely or probably take a brain health test and 86% would do so even if it gave information about a disease that cannot be treated or prevented. The main reason for taking a test was the ability to respond if one was found to be at risk of brain disease, such as changing lifestyle, seeking counseling or starting treatment. Higher interest in brain health testing was found in men, respondents with lower education levels and those with poor self-reported cognitive health.

Conclusion: High public interest in brain health and brain health testing in certain segments of society, coupled with an increase of commercial tests entering the market, is likely to put pressure on public health systems to inform the public about brain health testing in years to come.

Introduction

The concept of brain health has emerged in recent years to describe the state of brain functioning. It is a multifaceted concept because it refers to how well a person's brain functions across several areas including cognitive, emotional, sensory and motor function (1). The World Health Organization emphasize the importance of brain health to allow a person to realize their full potential over the life course, irrespective of the presence or absence of disorders (2). Others define brain health at any given age as the preservation of optimal brain integrity and mental and cognitive function in the absence of overt brain diseases (3). Recently, a new definition of brain health also takes into consideration mental health, wellbeing, and happiness, defining brain health in adults as "a state of complete physical, mental, and social wellbeing through the continuous development and exercise of the brain" (4). In this study, we provided participants with the following description of brain health, based on the US National Institute on Aging's information to the public (1): "Brain health is about your ability to remember, learn, plan, concentrate, and handle challenges. It is also about your ability to be mentally and emotionally in balance. Simply said, brain health is about making the most of your brain and taking care of it."

Brain health can be affected by a wide range of brain disorders i.e., neurological and psychiatric disorders, such as dementia, Parkinson, stroke, depression, schizophrenia and autism. Due to increased longevity, brain health related diseases are expected to increase in the coming decades, worldwide (5). Most brain diseases have a multifactorial origin, where genetic and environmental risk factors play an important role. For instance, about 40 percent of dementia cases might be prevented through lifestyle changes, potentially reducing health care needs over the next decades (6). Public awareness of brain health and the associated life factors is therefore becoming an increasingly important public health issue (7). In this paper we argue that public interest in brain health and brain health testing, coupled with a commercial drive for more brain health tests, is likely to put pressure on public health systems in years to come.

There are relatively few studies based on the broad concept of brain health; research is still mostly focused on one or few specific aspects of it (for e.g., dementia, cognition etc.). Studies that have explored brain health awareness find that people are generally conscious of their brain health and are interested in learning more about it, although they are less aware of brain health than other health issues (8–12). Studies report a varying level of knowledge of lifestyle factors (such as sleep, diet, physical activity, substance use etc.) influencing brain health. Studies find low awareness of the importance of systemic diseases, such as cardiovascular disease and diabetes, for the brain (12, 13). Confusion about which activities and factors benefit brain health has been apparent and illustrates the need for more evidence-based information regarding risk-reducing strategies. Although studies find people have positive intentions to change current brain health behavior, the intention-behavior gap is still high in the field of brain health as well (14, 15). Symptoms of cognitive or mental decline, knowledge of disease risk or having family members with brain diseases are reported as some of the key motivating factors for behavioral changes (11, 15).

In line with the numerous studies that have documented high public interest in medical testing (16), several studies have found relatively high public interest in testing for specific brain diseases, such as Alzheimer's disease (AD) (13, 17–20). Public interest in the early detection of dementia seems to be connected with large expectations about the effectiveness of

prevention. These expectations may be partly driven by the positive media reporting of medical breakthroughs in general, particularly related to genetic research (21). New genetic tests for assessing risk for specific brain diseases, such as Alzheimer's disease, are becoming available and are often reported in the media (22).

At present however, no single test can comprehensively assess or quantify brain health (3). Different aspects of brain health can be measured using different methods, such as genetic tests, biomarkers, neuroimaging and various cognitive and memory tests (3, 23), but existing tests have varying diagnostic validity, and for many conditions there is often a lack of effective prevention and treatment. Apart from Huntington's Disease and some rare mutations causing early-onset Alzheimer's disease, the predictive value of genetic testing for common brain diseases is uncertain (24), as for instance, many individuals suggested to be at risk for dementia might never develop symptoms, and abnormal disease biomarkers are also prevalent in healthy old people leading to false positives and low specificity of such tests (25). Also, studies typically find only limited influence of genetic information on subsequent illness and risk-related lifestyle changes (26). Consequently, most clinicians do not recommend pre-symptomatic tests for learning about personal risks for dementia, such as Alzheimer's disease (27, 28). Genotyping furthermore raises legal questions about testing protocols, disclosure practices, confidentiality, insurance and employment discrimination, and the availability of follow-up care (19). Nevertheless, the emergence of commercial genetic tests and overly positive media coverage of the benefits of medical testing is rapidly increasing availability and consumer spending on medical testing, including neurological tests (22, 29, 30).

Few studies have explored public interest in undertaking testing to learn about their personal brain health, or what motivates such an interest. Given the substantial public interest in brain health and the growing availability of commercial medical testing, there is a need to explore whether people are interested in testing their brain health, and what motivates such an interest in testing (or not). The purpose of this paper is therefore to explore people's interest in undertaking a hypothetical brain health test to learn about their risk of developing a brain disease.

As part of a large-scale international survey—the Global Brain Health Survey (GBHS) (31)—respondents were asked to imagine "a simple brain health test to learn about risk of developing a brain disease," With brain health tests, we hence refer to hypothetical, non-invasive tests for risk of non-specified brain disease, rather than any known test available today. The generalized description of the test was intentional to capture overall interest and willingness to learn about the general risk of brain disease, rather than specific diseases. We explored how views differ across individual and sociodemographic characteristics. The survey provided an unusually large international sample of interested people, and,

despite the selective nature of the sample, this study provides new knowledge and useful insights about public perspectives on brain health testing that may be relevant for public health policy makers at European and international levels.

Materials and methods

The survey

The GBHS was organized as part of the research project "Lifebrain; Healthy minds from 0 to 100 years: Optimizing the use of European brain imaging cohorts," a 5 ½—year long research project in the Horizon 2020 program of the European Commission (32). The consortium combines data from 11 European cohorts to explore biological, cognitive, environmental, social, occupational, and lifestyle factors affecting brain health. The survey items in this study are a part of the Global Brain Health Survey, which covered several topics related to brain health and was available in 14 languages. The survey was anonymous and open to anyone above the age of 18 years consenting to participate. The whole survey took 15–20 min to complete and was freely available on the website www.lifebrain.uio.no. There was no compensation and participants had to have their own internet access, so incentives for fraud or duplications were low. A comprehensive description of the survey and its design can be found elsewhere (31). For this study, we investigated respondents' answers to six of the questions in the Global Brain Health Survey that were related to the theme of brain health testing. These were: (1) respondents' willingness to undertake such a test for their brain health to reveal risk of developing a brain disease, and (2) even if such diseases were unpreventable or not treatable, (3) reasons why they would take or (4) not take a brain health test, (5) their likely reactions to brain health test results and (6) the criteria they considered important, such as tests being affordable, quick, accurate, or painless.

Sampling

The original objective of the survey was to reach as many people as possible in Europe and beyond, and the goal was to achieve a sample size of 10,000 (31). To reach this large number, a convenient sampling strategy was adopted and the survey was distributed using using newsletters, information on websites and social media of the participating brain health organizations and research networks in the Lifebrain project. This included the brain research registries Hersenonderzoek in the Netherlands and Join Dementia Research in the UK with a volunteer base of 34,000+ and 50,000+ respectively, of which ∼20% participated in this survey. The large proportion of participants recruited via such registers makes it likely that

the overall sample was particularly interested in brain health and thus not representative of the general population. The remainder of the respondents in the UK and NL had been recruited through research organizations, brain foundations and research networks connected to the Lifebrain project, like the participants in the other countries. Data was collected between June 2019 to August 2020. A full description of the population and sampling strategy has been published previously (12).

Measures

The GBHS survey included 16 multiple choice questions that covered four themes: perceptions of brain health, interest in brain health tests, motivations to look after one's brain health and support needed to promote brain health. In this paper we investigate the responses to the part of the survey that addressed respondents' interest in undertaking brain health tests, defined as a willingness to test for risk of developing brain disease. These were:

1) Willingness to take a brain health test: "Imagine a simple brain health test to learn about risk of developing a brain disease. Would you wish to take such a test?" Respondents could select: Yes—definitely; Yes—probably; No—probably not; No—definitely not.

2) Willingness to test for unpreventable or untreatable diseases: "Would you take a test even if it provides information about a disease that cannot be prevented or treated?" Respondents could choose between: Yes—definitely; Yes—probably; No—probably not; No—definitely not.

3) Reasons for taking a brain health test: "Why would you take a brain health test?" Respondents were asked to select the one or two most important out of the following: (a) To get information about my cognitive and mental health, (b) To determine my risk of developing a brain disease, (c) To respond if I am at risk, e.g., change my lifestyle, seek counseling, or start treatment, (d) To prepare myself for the future (e.g., inform my family about the risk), (e) Other motivation (please specify).

4) Reasons for NOT wanting to take a brain health test, if they answered No to question 1; "Would you wish to take a test"): "Why would you NOT take a brain health test¿' Respondents were asked to select up to two most important reasons, out of the following options: (a) I do not want to worry about something that may not happen, (b) I do not want to know about a disease that could not be prevented or treated, (c) I would be frightened by the result, (d) There is nothing I can do for my brain health anyway, or (e) Other reasons (please specify).

5) Likely reactions to test results on brain health risk: "Imagine you undergo a brain health test, and it shows that you have a risk of developing brain disease. What would be your most likely reaction?" Respondents were presented with a list of reactions and were asked to rate these using a four-item

Likert scale (definitely yes, fairly likely, fairly unlikely, definitely not): (a) I would seek professional help (e.g., my doctor), (b) I would seek advice from family and friends, (c) I would seek information online/at the library, (d) I would change my lifestyle if required, (e) I would plan for the future, and (f) Is there anything else you think you might do? Please describe (free text).

6) Brain health test criteria: Respondents were asked to imagine it was possible to take a simple brain health test, like measuring blood pressure or cholesterol levels, to reveal risk of developing brain disease. Respondents were asked to select the one to three most important characteristics that such a brain health test should have: (a) Affordable, (b) Quick to take, (c) Accurate, (d) Painless, (e) Subsidized by social security (via the GP), (f) Offered online with direct access to the results, (g) Other (please specify).

We also explore 10 demographic variables related to: age, gender (self-identified), education level, relationship status, experience or education in health care, experience of long-standing illness or disability, experience of taking care of a family member with brain disease, experience with taking part in brain research, self-assessed cognitive health, and self-assessed mental health. For the variable "self-assessed cognitive health" respondents were asked: "How would you describe your ability to think, remember and learn? (Excellent, above average, average, below average or very poor). For "self-assessed mental health" respondents were asked; "How would you describe your ability to balance your mood and emotional well-being?" (Excellent, above average, average, below average or very poor). For the gender category, there were four options: Male, female, other, prefer not to answer.

Analysis

For the analyses of demographic differences, responses were analyzed using generalized binomial linear models with R version 4.1.0 (33) at a 99% level of significance. To reduce unnecessary complexity, survey questions which contained data from multiple response categories, were collapsed into binary response categories. For the first question (Would you wish to take such a test?) and second question (*Would you take a test even if the disease cannot be treated or prevented*?), the responses "Yes, definitely" and "yes, probably" were categorized as a positive association between the question and the response, while "No, probably not," and "No, definitely not" were categorized as a negative association. Responses for the third, fourth and sixth questions were binary. For the fifth question (*What would be your most likely reaction?)*, the response categories "Definitely yes" and "Fairly likely" were categorized as being likely to react in the given way (positive association), and "Fairly unlikely" and "Definitely not" were categorized as being unlikely to react in the given way (negative association).

For each response we estimated 10 models, using a single predicting demographic variable for each model, to analyse the relationship between responses and demographic characteristics. To simplify data interpretation, complex demographic variables were reduced to three or fewer data categories. Education level was reduced to either "higher education" (university/college degree) or "lower education" (primary school, special educational school, secondary school, vocational training). Age was reduced to three categories, "young adult" (40 and below), "middle-aged" (41 to 60 years) or "old adult" (above 60 years). Self-assessed mental and cognitive health were categorized as either "good" mental or cognitive health (encompassing response categories "average," "above average" and "excellent"), or "poor" mental or cognitive health (below average or very poor). Relationship status was reduced as either in a stable relationship ("married," "stable relationship, not married") or single ("divorced/separated," "widow/widower," "single"). The response category with the highest number of data points was used as the reference group.

Due to the large sample size, almost all group differences were statistically significant but not necessarily of practical importance. Thus, in the results section we report only Odds Ratios (ORs) of the binarized responses showing the most important differences. All reported ORs in the text are significant at the 1% level of probability. Complete tables of all the descriptive statistics for all variables are provided in the online Supplementary material, as well as models for continuous data for robustness.

Results

Respondent characteristics

Twenty seven thousand five hundred and ninety people from 81 countries participated in the survey, mostly from Europe (98%): 36.8% in the United Kingdom, 25.5% in the Netherlands, 12.9% in Norway, 7.6% in Spain, 4.0% in Denmark, 3.8% in Germany, 2.8% in Sweden, 1.1% in Italy and 1.1% in Ukraine. Respondents outside of Europe primarily lived in the United States (0.6%) or Turkey (0.5%). 1.7% were from other parts of the world. Most respondents were middle aged-or older (>40 years; 83.6%), female (71.1%), had a university/college degree (68.6%), and were in a stable relationship (71.8%). Forty-three percent of the respondents had participated in brain research, 38.5% had education or work experience in health care, 46.5% had experience with looking after a family member with brain disease and 40.4% had long-standing illness, disability, or health problems.

Over half (58%) had been recruited through the two research registries in the UK and the Netherlands. To illustrate the selectivity of recruitment, we compared those participants recruited through *Join Dementia Research* ($n = 9,878$) in the

UK and *Hersenonderzoek* ($n = 6,117$) in the Netherlands (NL) with the remainder of respondents from UK ($n = 1,074$) and NL ($n = 974$), respectively. Figure 1 shows that registry members were slightly more willing to take a 'brain health test' than others. As expected, a larger proportion of registry participants had taken part in brain research than respondents not on a registry. Fewer had education or work experience in brain health, thus highlighting a separate source of interest for non-registry members. UK but not Dutch registry participants were more commonly looking after a family member ("ever been a carer"; 57.7% vs. 39.3%). This illustrates not only the obvious differences, but also the selectiveness of the respondents not part of research registries (the percentage of other respondents engaged in research was >25%).

Willingness to take a brain health test

Most respondents (60%) would "definitely" take a simple brain health test to learn about risk of developing a brain disease, whereas 31% would "probably" take such a test. Only 1% would "definitely not" take a test.

Table 1 shows the differences in willingness to take a brain health test, as well as tests for untreatable diseases, between demographic groups of respondents. Respondents willing to take a test had higher chances of being men (OR 1.75, 99% CI 1.52–2.01), having lower education (OR 1.52, 99% CI 1.34–1.72), and poor self-reported cognitive health (OR 1.48, 99% CI 1.13–1.93). They were also more likely to have had experience with long-standing illness or disability (OR 1.25, 99% CI 1.11–1.40) and to have had participated in brain health research (OR 1.31, 99% CI 1.17–1.46).

Young respondents (40 or younger) were less likely to want to take a brain health test (OR 0.65, 99% CI 0.56–0.76), as well as respondents with employment and/or education in healthcare (OR 0.70, 99% CI 0.63–0.78).

Willingness to test for unpreventable or untreatable diseases

When asked whether they would want to test for risk of developing brain disease that was unpreventable or untreatable, 43% of respondents would "definitely" take a brain health test even if it provided such information, and 43% would "probably" do the same.

Table 1 shows that respondents with lower education (OR 1.39, 99% CI 1.25–1.55), poor self-reported cognitive health (OR 1.85, 99% CI 1.45–2.36), personal experience of chronic illness (OR 1.39, 99% CI 1.26–1.54), or who had cared for a family member with brain disease (OR 1.20, 99% CI 1.09–1.32) were more likely to take a brain health test even for an untreatable disease than respondents without these
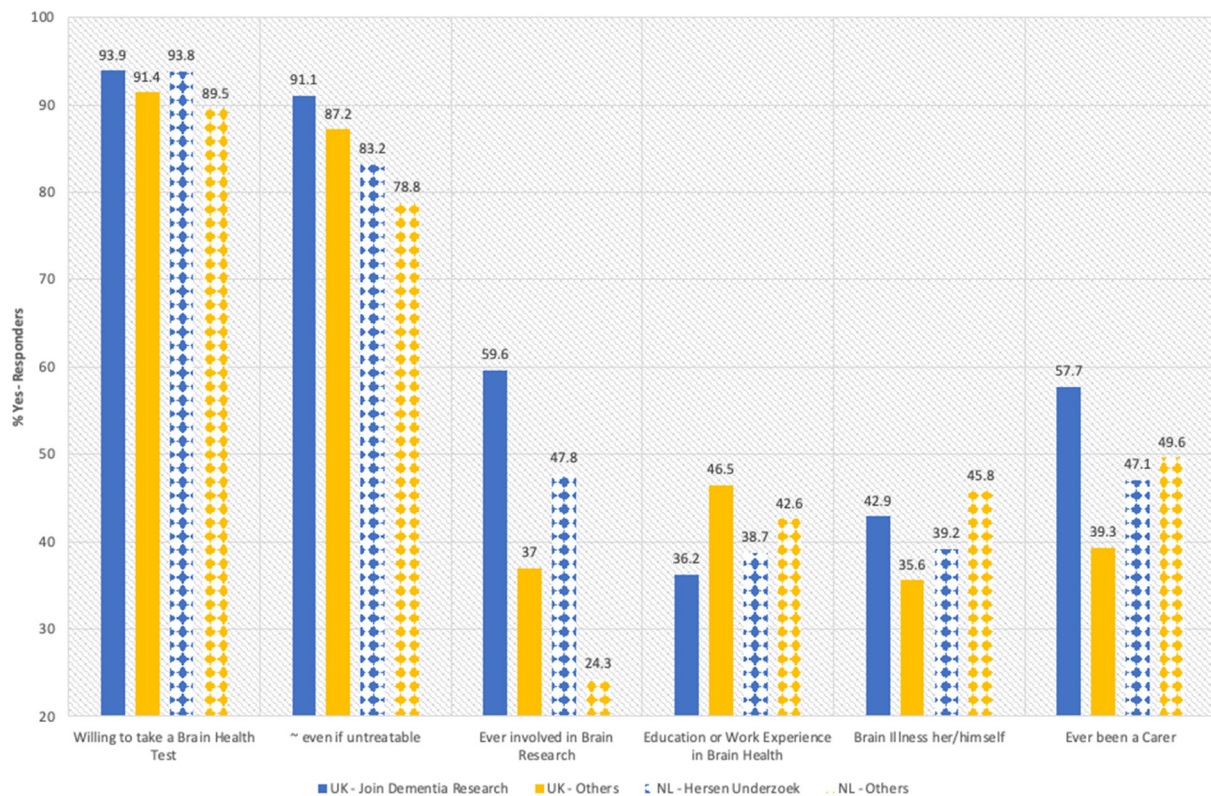
FIGURE 1
Comparison between participants from research registries and the remainder from same country. The graph shows how the participants recruited from research registries *Join Dementia Research* and *Hersenonderzoek* answered relevant questions compared with other respondents from the same country (UK and NL others).

characteristics. Furthermore, men were more likely to take such a test compared to women (OR 1.76 99% CI 1.56–1.97).

Young respondents (40 and below) (OR 0.59, 99% CI 0.52–0.67) and respondents with employment and/or education within healthcare were less likely to test for risk of disease that is unpreventable and untreatable (OR 0.71, 99% CI 0.64–0.78) compared to older respondents (above 60) and those without healthcare experience.

Reasons for taking a brain health test

As shown in Figure 2, the main reason (48%) for wanting to take a brain health test was to be able to respond if found to be at risk of a brain disease. The other two main reasons were learning about the risk of developing a brain disease (34%) and to get information about cognitive and mental health (32%).

Table 2 shows that, compared to older respondents, younger respondents were more likely to take a test in order to respond

if they were at risk (OR 1.50, 99% CI 1.37–1.66), and to get information about their cognitive and mental health (OR 1.74, 99% CI 1.58–1.91), but were less likely to take a test to (just) learn about their risk of developing a brain disease (OR 0.75, 95% CI 0.68–0.83).

Respondents with poor cognitive health (OR 0.78, 99% CI 0.68–0.89) and those with lower education (OR 0.77, 95% CI 0.72–0.83) were less likely to take a test to respond to risk compared to respondents without these characteristics.

Respondents who wanted to take a test to get information about cognitive and mental health were more likely male (OR 1.16, 95% CI 1.07–1.25), and with poor mental health (OR 1.25, 99% CI 1.13–1.38).

Respondents more interested in preparing for the future were more likely to have had participated in brain research (OR 1.53, 99% CI 1.41–1.66) and to have had experience in taking care of a family member with brain disease (OR 1.46, 99% CI 1.35–1.58), than respondents without these characteristics. Younger respondents were less likely to take a test in order to prepare for the future (OR 0.51, 99% CI 0.45–0.58).

TABLE 1 Probability of taking a brain health test (question 1), and probability of taking a test even if it provides information about a disease that cannot be prevented or treated (question 2), by demographic groups.

Variable	Characteristics	Willingness to take a brain health test			~even if illness is not preventable or untreatable		
		%	OR	99% CI	%	OR	99%CI
Gender	Women	90.0			84.5		
	Men	94.0	1.75	1.52–2.01	90.5	1.76	1.56–1.97
	Other/Undisclosed	80.9	0.47	0.27–0.84	85.8	1.11	0.54–2.29
Age	>60 years	92.6			88.4		
	41–60 years	90.2	0.73	0.65–0.83	85.4	0.77	0.69–0.85
	≤40 years	89.0	0.65	0.56–0.76	81.9	0.59	0.52–0.67
Education	Higher education	90.1			85.1		
	Lower education	93.2	1.52	1.34–1.72	88.8	1.39	1.25–1.55
Cognitive health	Average or above	90.9			85.9		
	Below average	93.7	1.48	1.13–1.93	91.8	1.85	1.45–2.36
Mental health	Average or above	91.1			86.1		
	Below average	91.1	1.00	0.85–1.17	87.3	1.11	0.96–1.28
Caregiver exp.	No	90.8			85.3		
	Yes	91.4	1.09	0.97–1.21	87.4	1.20	1.09–1.32
Illness experience	No	90.4			84.7		
	Yes	92.1	1.25	1.11–1.40	88.5	1.39	1.26–1.54
Brain research exp.	No	90.2			84.6		
	Yes	92.3	1.31	1.17–1.46	88.4	1.39	1.26–1.54
Health care exp.	No	92.2			87.9		
	Yes	89.3	0.70	0.63–0.78	83.6	0.71	0.64–0.78

% Indicates the proportion of participants answering "Yes, definitely" or "yes, probably" to the question, with the remainder of participants answering "No—probably not" or "No—definitely not." OR, Odds ratio; CI, Confidence interval.

FIGURE 2
Reasons for taking a brain health test. Respondents who answered they would take a brain health test could select up to two most important reasons for doing so. Percentages indicate the proportion of respondents who chose each reason (percentages exceed 100% in total because respondents could choose up to two reasons).
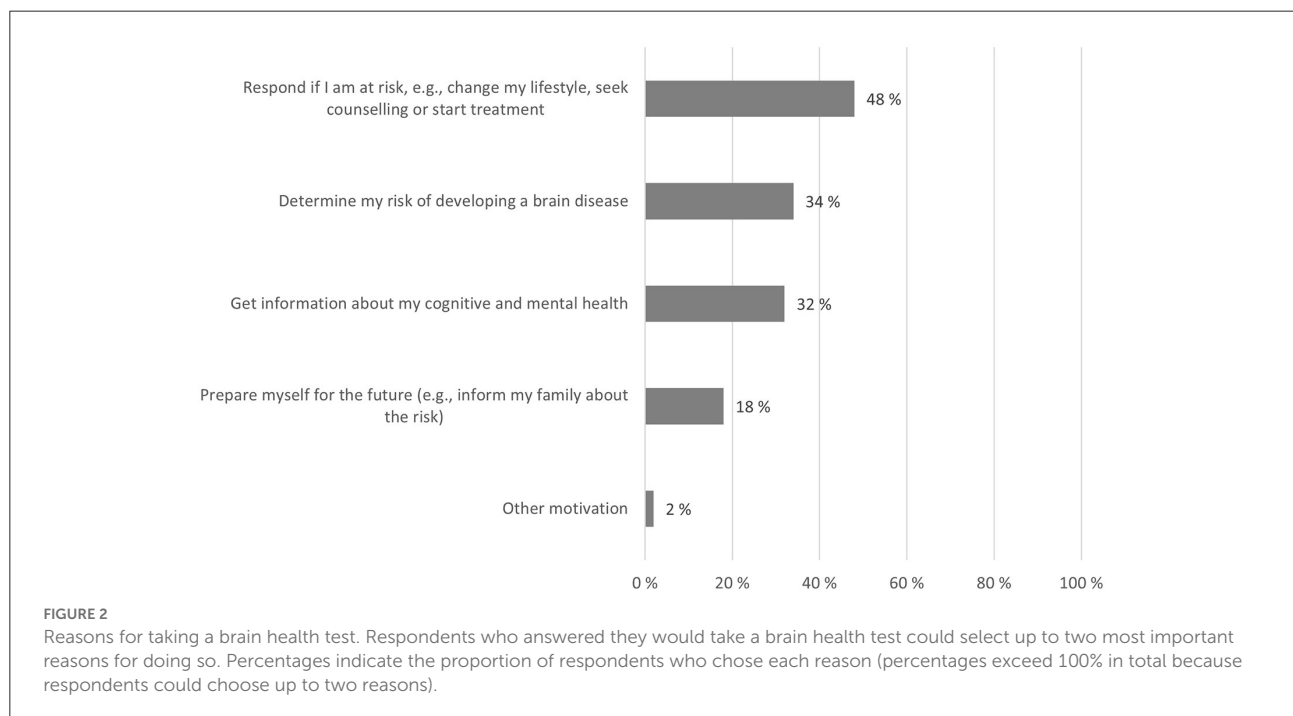
TABLE 2 Reasons for wanting to take a brain health test.

Variable	Characteristics	Respond if at risk			Learn about risk			Get information		
		%	OR	99% CI	%	OR	99%CI	%	OR	99%CI
Gender	Women	47.8			33.8			31.0		
	Men	49.4	0.98	0.91–1.05	34.8	0.98	0.91–1.05	35.5	1.16	1.07–1.25
	Other/Undisclosed	44.3	1.07	0.64–1.77	20.6	0.57	0.32–1.01	36.6	1.58	0.95–2.61
Age	>60 years	46.2			35.8			31.2		
	41–60 years	48.4	1.16	1.08–1.25	34.0	0.96	0.89–1.03	29.6	0.96	0.89–1.04
	≤40 years	53.4	1.50	1.37–1.66	28.7	0.75	0.68–0.83	41.7	1.74	1.58–1.91
Education	Higher education	49.5			32.6			32.5		
	Lower education	45.3	0.77	0.72–0.83	36.9	1.15	1.07–1.24	31.8	0.92	0.85–0.99
Cognitive health	Average or above	48.5			33.9			32.1		
	Below average	44.0	0.78	0.68–0.89	35.0	1.00	0.87–1.15	34.4	1.06	0.92–1.22
Mental health	Average or above	48.2			34.4			31.7		
	Below average	48.4	1.01	0.92–1.11	31.4	0.87	0.78–0.96	36.3	1.25	1.13–1.38
Caregiver exp.	No	49.8			32.5			35.4		
	Yes	46.3	0.84	0.79–0.90	35.7	1.15	1.07–1.23	28.7	0.72	0.67–0.77
Illness experience	No	48.5			34.2			31.5		
	Yes	47.7	0.93	0.87–0.99	33.7	0.95	0.89–1.02	33.4	1.06	0.99–1.13
Brain research exp.	No	48.2			33.3			33.4		
	Yes	48.1	0.95	0.89–1.01	34.9	1.04	0.97–1.11	30.8	0.85	0.79–0.91
Health care exp.	No	48.4			34.5			32.7		
	Yes	47.8	1.04	0.98–1.12	33.1	0.99	0.92–1.06	31.6	1.00	0.93–1.07

Variable	Characteristics	Prepare for the future			Other motivation					
		%	OR	99% CI	%	OR	99% CI	%	OR	99%CI
Gender	Women	18.4			2.0					
	Men	18.3	0.94	0.86–1.03	2.0	0.93	0.73–1.19			
	Other/Undisclosed	22.9	1.53	0.88–2.68	3.1	1.71	0.45–6.39			
Age	>60 years	21.7			2.0					
	41–60 years	17.1	0.76	0.70–0.83	2.3	1.20	0.95–1.52			
	≤40 years	12.0	0.51	0.45–0.58	1.4	0.76	0.53–1.09			
Education	Higher education	18.6			1.8					
	Lower education	18.1	0.93	0.85–1.01	2.6	1.42	1.13–1.78			
Cognitive health	Average or above	18.3			1.9					
	Below average	19.7	1.05	0.89–1.24	4.2	2.20	1.57–3.09			
Mental health	Average or above	18.7			1.8					
	Below average	16.6	0.86	0.76–0.98	3.5	2.00	1.53–2.60			
Caregiver exp.	No	15.8			1.6					
	Yes	21.5	1.46	1.35–1.58	2.5	1.63	1.30–2.04			
Illness experience	No	17.7			1.6					
	Yes	19.4	1.09	1.01–1.19	2.7	1.71	1.37–2.14			
Brain research exp.	No	15.5			1.9					
	Yes	22.2	1.53	1.41–1.66	2.2	1.12	0.90–1.40			
Health care exp.	No	18.7			2.2					
	Yes	18.0	1.00	0.92–1.08	1.7	0.81	0.64–1.03			

% Indicates the proportion of participants selecting each reason. OR, Odds ratio; CI, Confidence interval.

Reasons for NOT taking a brain health test

Of the respondents who did not want to take a test (9%), most did not want to know about a disease that could not be prevented or treated, and a quarter did not want to worry about something that might not happen (Figure 3).

Table 3 shows that, out of the respondents who did not want to take a test, respondents with lower levels of education would to a larger extent not want to worry about something that might not happen (OR 1.57, 99% CI 1.20–2.04), and would be more frightened by the results (OR 1.49, 99% CI 1.04–2.14) compared to those with higher levels of education.

Younger respondents and those with poor mental health would to a larger extent avoid testing because they would be frightened by the results compared to older respondents (OR 1.87, 99% CI 1.21–2.89) and those with good mental health (OR 1.78, 99% CI 1.17–2.72).

Respondents with experience of taking care of a family member with brain disease were more likely to not want to know about a non-preventable or untreatable disease (OR 1.27, 99% CI 1.02–1.57) compared to those without such experience.

Likely reactions to test results

Almost all respondents (above 95%) said that they would definitely or be fairly likely to change their lifestyle if necessary, seek professional help, and plan for the future based on the results of the (hypothetical) brain health test (Figure 4).

Table 4 shows that young respondents were less likely to seek professional help (OR 0.51, 99% CI 0.40–0.65), or to use test results to plan for the future (OR 0.66, 99% CI 0.55–0.80) compared to older respondents.

Respondents with lower education were more likely to seek professional help (OR 1.31, 99% CI 1.07–1.61) but less likely to plan for the future (OR 0.63, 99% CI 0.55–0.73) or seek information (OR 0.53, 99% CI 0.48–0.59) compared to respondents with higher education. In comparison, respondents with employment or education within healthcare were less likely to seek professional help (OR 0.65, 99% CI 0.54–0.77), but more likely to plan for the future (OR 1.25, 99% CI 1.07–1.45) and seek information (OR 1.29, 99% CI 1.16–1.45) compared to respondents without such experience. Respondents who had taken care of next of kin with brain disease were also more likely to plan for the future (OR 1.77, 99% CI 1.52–2.06) and to seek information (OR 1.24, 99% CI 1.12–1.39), in addition to changing their lifestyle (OR 1.34, 99% CI 1.08–1.67), compared to those without such experience.

Respondents with health-issues were overall less interested in changing their lifestyle than other respondents, including

FIGURE 3
Reasons for NOT taking a brain health test. Respondents who answered they would not take a test, were asked to select up to two most important reasons for not doing so. Numbers indicate the percentage of respondents who chose each reason (percentages exceed 100% in total because respondents could choose up to two reasons).
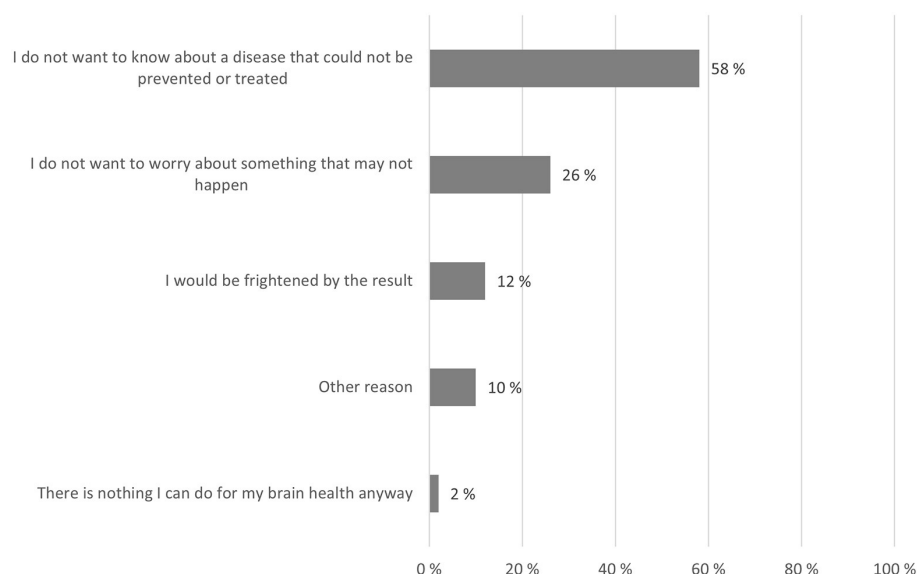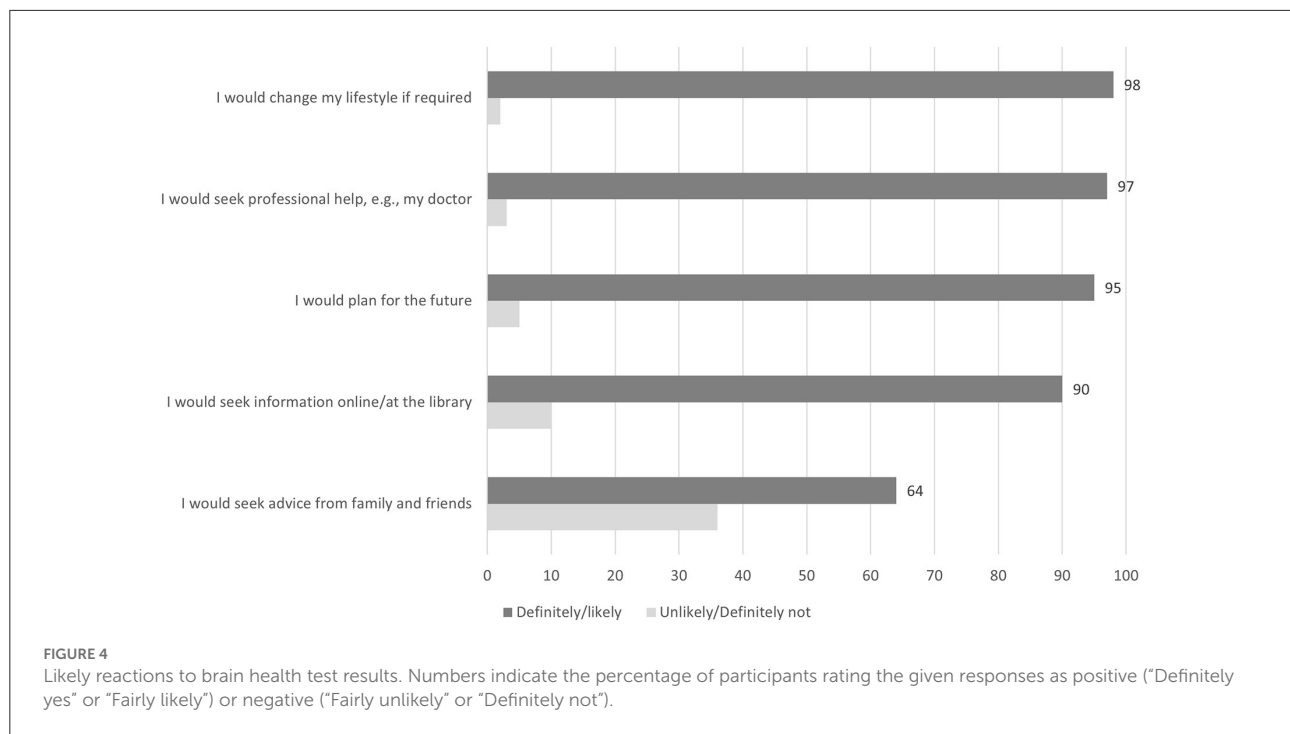
TABLE 3 Reasons for NOT wanting to take a brain health test.

Variable	Characteristics	Do not want to know			Do not want to worry			Frightened by the result		
		%	OR	99% CI	%	OR	99%CI	%	OR	99%CI
Gender	Women	59.4			26.7			11.7		
	Men	55.0	0.84	0.64–1.09	27.3	1.03	0.76–1.39	9.6	0.80	0.51–1.24
	Other/Undisclosed	32.0	0.32	0.11–0.98	40.0	1.83	0.63–5.29	16	1.43	0.35–5.91
Age	>60 years	60.1			27.5			8.9		
	41–60 years	56.2	0.85	0.67–1.08	26.5	0.95	0.73–1.23	11.8	1.38	0.93–2.03
	≤40 years	58.8	0.95	0.71–1.27	26.9	0.97	0.70–1.33	15.4	1.87	1.21–2.89
Education	Higher education	61.0			24.7			10.3		
	Lower education	49.4	0.62	0.49–0.80	34.0	1.57	1.20–2.04	14.7	1.49	1.04–2.14
Cognitive health	Average or above	58.3			27.1			11.3		
	Below average	58.1	0.99	0.59–1.67	23.8	0.84	0.46–1.54	14.3	1.31	0.63–2.75
Mental health	Average or above	58.1			27.2			10.5		
	Below average	59.3	1.05	0.77–1.43	25.6	0.92	0.65–1.31	17.3	1.78	1.17–2.72
Caregiver exp.	No	55.7			28.0			12.5		
	Yes	61.4	1.27	1.02–1.57	25.7	0.89	0.70–1.13	9.9	0.77	0.55–1.08
Illness experience	No	58.8			26.7			10.9		
	Yes	57.2	0.94	0.75–1.17	27.5	1.04	0.82–1.33	12.3	1.15	0.82–1.61
Brain research exp.	No	57.7			29.2			12.8		
	Yes	59.3	1.07	0.86–1.33	23.1	0.73	0.57–0.93	8.9	0.67	0.47–0.95
Health care exp.	No	56.6			27.9			12.2		
	Yes	60.1	1.15	0.93–1.43	25.9	0.90	0.71–1.14	10.4	0.84	0.60–1.17

Variable	Characteristics	Other reasons			Nothing I can do anyway					
		%	OR	99% CI	%	OR	99% CI	%	OR	99%CI
Gender	Women	10.2			1.0					
	Men	13.0	1.31	0.88–1.96	3.2	3.39	1.37–8.34			
	Other/Undisclosed	20.0	2.20	0.60–8.09	4.0	4.27	0.29–63.5			
Age	>60 years	9.2			2.4					
	41–60 years	13.4	1.53	1.05–2.22	1.0	0.40	0.15–1.07			
	≤40 years	8.9	0.97	0.59–1.59	0.4	0.16	0.02–1.10			
Education	Higher education	10.7			1.0					
	Lower education	11.5	1.08	0.74–1.59	2.9	3.09	1.28–7.45			
Cognitive health	Average or above	10.9			1.3					
	Below average	9.5	0.86	0.36–2.06	4.8	3.87	1.08–13.8			
Mental health	Average or above	11.3			1.4					
	Below average	7.7	0.65	0.37–1.15	1.9	1.37	0.43–4.41			
Caregiver exp.	No	11.4			1.5					
	Yes	10.1	0.87	0.62–1.22	1.3	0.83	0.34–2.02			
Illness experience	No	10.5			1.5					
	Yes	11.4	1.09	0.77–1.54	1.3	0.83	0.32–2.12			
Brain research exp.	No	8.8			1.7					
	Yes	14.3	1.72	1.23–2.41	1.0	0.58	0.21–1.58			
Health care exp.	No	10.6			1.7					
	Yes	11.1	1.05	0.75–1.47	1.1	0.60	0.24–1.51			

% Indicates the proportion of participants selecting each reason. OR, Odds ratio; CI, Confidence interval.

Likely reactions to brain health test results. Numbers indicate the percentage of participants rating the given responses as positive ("Definitely yes" or "Fairly likely") or negative ("Fairly unlikely" or "Definitely not").

those with experience of long-standing disability or illness (OR 0.74, 99% CI 0.60–0.91), with poor cognitive health (OR 0.43, 99% CI 0.31–0.59), or poor self-rated mental health (OR 0.49, 99% CI 0.38–0.63).

Brain health test criteria

Asked to indicate up to three of the most important criteria of a brain health test, respondents thought a test should be accurate (82%), affordable (48%), and be subsidized by social security (46%, see Figure 5).

Table 5 shows that young respondents thought it was more important that tests were affordable (OR 1.39, 99% CI 1.27–1.52), subsidized (OR 1.23, 99% CI 1.13–1.35) and not painful (OR 1.69, 99% CI 1.55–1.86) compared to older respondents. They were also less likely to think that tests were accurate (OR 0.63, 99% CI 0.56–0.71), available online (OR 0.52, 99% CI 0.47–0.58) or quick (OR 0.82, 99% CI 0.74–0.90) compared to older respondents.

Men thought it was more important that tests were quick (OR 1.22, 99% CI 1.13–1.31) than women. For respondents with lower education, subsidization of tests was more important (OR 1.25, 99% CI 1.17–1.33) than to those with higher education.

Respondents with poor cognitive health thought test subsidization was more important (OR 1.27, 99% CI 1.12–1.45) than those with good cognitive health, as did respondents with experience of long-standing illness or disability (OR 1.24, 99% CI 1.17–1.33) and respondents with poor mental health OR

1.21, 99% CI 1.10–1.33). Respondents with poor cognitive health thought it was less important that a test should be painless (OR 0.78, 99% CI 0.67–0.90) or quick (OR 0.80, 99% CI 0.69–0.93). Similarly, respondents with poor mental health thought it was less important that tests were quick (OR 0.81, 99% CI 0.73–0.90) than respondents with good mental health.

Test accuracy was more important to respondents who had cared for family members with brain disease (OR 1.29, 99% CI 1.19–1.41), and to respondents who had participated in brain research (OR 1.62, 99% CI 1.49–1.77), than other respondents.

Discussion

Summary of findings

This study is based on an international survey on public perspectives of brain health with 27,590 respondents and is one of the largest surveys to date. We explored public willingness to test for brain disease, and the motivation for doing so. Our main findings were that we found high public interest in brain health testing, even for diseases that cannot be treated or prevented. Further, those most interested in brain health testing were older (above 60), male, lower educated and with poorer cognitive health. The main reason for taking a test was to be able to act if they were found to be at risk of brain disease, such as changing lifestyle, seeking counseling or starting treatment. Most people said they would seek professional help and change their lifestyle if a test revealed they were at risk of brain disease. Of all the

TABLE 4 Likely reactions to test results if found to be at risk of brain disease.

Variable	Characteristics	Change my lifestyle			Seek professional help			Plan for the future		
		%	OR	99% CI	%	OR	99%CI	%	OR	99%CI
Gender	Women	98.0			96.8			95.6		
	Men	97.2	0.71	0.57–0.89	97.3	1.21	0.98–1.50	93.8	0.70	0.60–0.82
	Other/Undisclosed	90.2	0.19	0.08–0.41	91.8	0.37	0.16–0.87	86.1	0.29	0.15–0.57
Age	>60 years	97.7			97.7			95.3		
	41–60 years	98.0	1.16	0.91–1.47	96.6	0.66	0.53–0.81	95.6	1.08	0.91–1.28
	≤40 years	97.4	0.89	0.67–1.19	95.6	0.51	0.40–0.65	93.0	0.66	0.55–0.80
Education	Higher education	97.7			96.7			95.7		
	Lower education	97.9	1.07	0.85–1.34	97.5	1.31	1.07–1.61	93.4	0.63	0.55–0.73
Cognitive health	Average or above	97.9			96.9			95.2		
	Below average	95.3	0.43	0.31–0.59	96.8	0.94	0.65–1.37	92.8	0.65	0.50–0.85
Mental health	Average or above	98.0			97.1			95.5		
	Below average	96.0	0.49	0.38–0.63	95.8	0.68	0.53–0.86	92.2	0.56	0.47–0.67
Caregiver exp.	No	97.5			97.0			93.8		
	Yes	98.1	1.34	1.08–1.67	96.8	0.93	0.78–1.12	96.4	1.77	1.52–2.06
Illness experience	No	98.0			96.7			95.3		
	Yes	97.4	0.74	0.60–0.91	97.2	1.19	0.98–1.43	94.6	0.85	0.73–0.98
Brain research exp.	No	97.6			96.9			94.3		
	Yes	98.0	1.25	1.01–1.56	97.0	1.01	0.84–1.22	96.0	1.47	1.26–1.71
Health care exp.	No	97.7			97.5			94.6		
	Yes	97.9	1.09	0.87–1.35	96.1	0.65	0.54–0.77	95.6	1.25	1.07–1.45

Variable	Characteristics	Seek information			Seek advice					
		%	OR	99% CI	%	OR	99% CI	%	OR	99%CI
Gender	Women	92.0			65.5					
	Men	86.6	0.57	0.51–0.63	62.1	0.86	0.80–0.93			
	Other/Undisclosed	91.2	0.91	0.40–2.05	62.5	0.88	0.54–1.43			
Age	>60 years	89.5			60.4					
	41–60 years	91.6	1.27	1.13–1.44	65.2	1.23	1.14–1.32			
	≤40 years	90.3	1.09	0.93–1.26	73.6	1.82	1.65–2.02			
Education	Higher education	92.3			64.7					
	Lower education	86.4	0.53	0.48–0.59	64.3	0.98	0.91–1.06			
Cognitive health	Average or above	90.5			64.7					
	Below average	89.6	0.90	0.73–1.13	61.6	0.87	0.76–1.01			
Mental health	Average or above	90.3			65.1					
	Below average	91.2	1.11	0.94–1.30	60.7	0.83	0.75–0.91			
Caregiver exp.	No	89.6			63.2					
	Yes	91.4	1.24	1.12–1.39	66.0	1.13	1.06–1.21			
Illness experience	No	90.5			65.3					
	Yes	90.4	1.00	0.90–1.12	63.5	0.92	0.86–0.99			
Brain research exp.	No	90.6			65.7					
	Yes	90.3	0.97	0.87–1.08	63.0	0.89	0.83–0.95			
Health care exp.	No	89.6			64.3					
	Yes	91.8	1.29	1.16–1.45	64.9	1.03	0.96–1.10			

% Indicates the proportion of participants selecting reaction. OR, Odds ratio; CI, Confidence interval.

Brain health test criteria. Respondents could select up to three most important criteria for brain health tests. Numbers indicate the percentage of respondents selecting the given response categories.
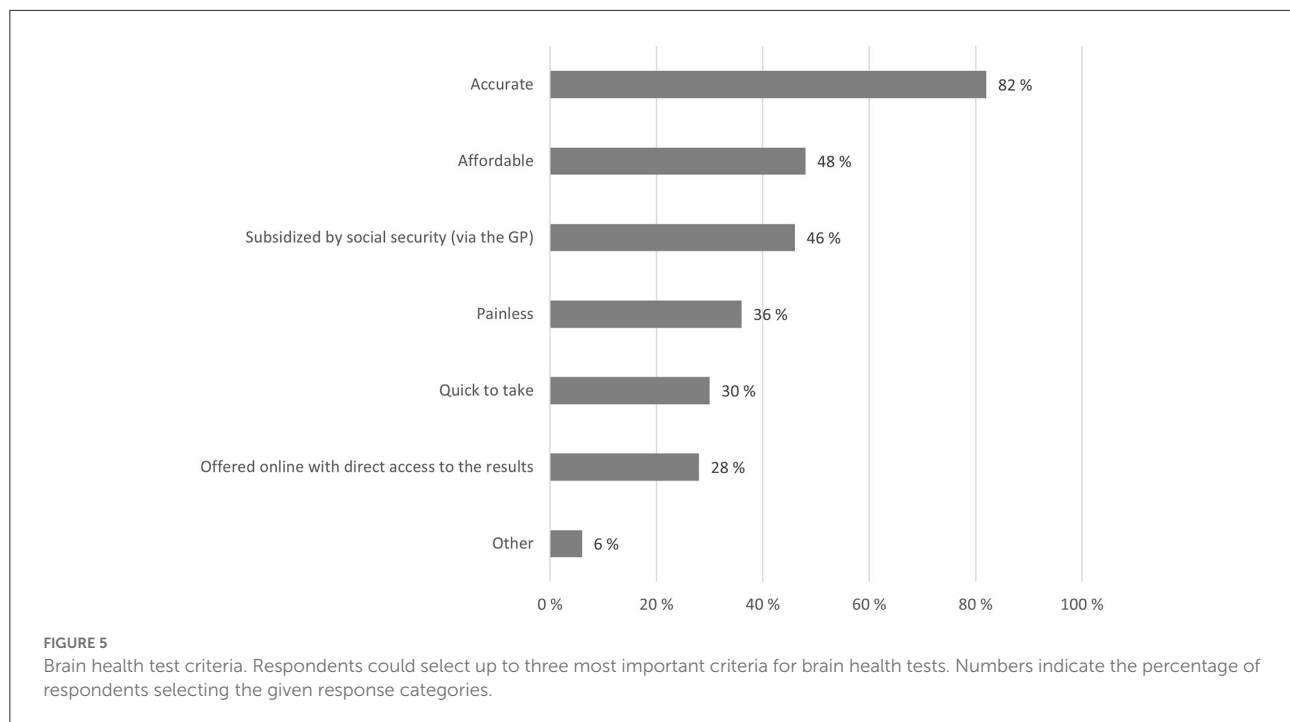
criteria for a good brain health test (price, invasiveness etc.), accuracy was rated as most important.

Interest in brain health testing

In our study 91% of respondents stated they would definitely or probably take a brain health test to learn about the risk of developing a brain disease, and 86% would do so even if the disease was untreatable or unpreventable. These findings are consistent with previous studies that also have found high public interest in testing for brain diseases (17, 19, 20, 27, 34–39). The relatively high interest in testing observed here is likely due to this survey's focus on brain diseases at large, rather than on a specific brain disease. For instance, willingness to test for specific diseases such as Alzheimer's disease has been found to be somewhat less than for other diseases (34). We also found that our respondents were somewhat less willing to test for unpreventable or untreatable brain diseases, as identified in other studies (13, 35, 40), but interest is still high. Nevertheless, experience suggests that actual uptake of testing may be lower than initial interest, particularly in the absence of treatment options (39, 40). Caution is therefore needed in translating test willingness into actual testing behavior.

Our results indicate differences across demographic characteristics in the willingness to test for brain disease. We found that older people, men, lower educated, those with poorer cognitive health and those with first-hand experience with disease, either through personal health issues or through family members with brain disease, are most interested in testing for brain disease, including for untreatable or unpreventable brain diseases. Our finding that testing interest corresponds with pre-existing health issues or caregiving experience of family members with brain disease supports the notion that personal experience with brain disease and perceptions of personal risk increases the relative willingness to undergo testing for brain disease (8, 11). For example, previous studies find that interest in predictive testing for brain disease is high among people with a family history of dementia, and among people participating in brain research (13, 27, 41). Several studies also find that personal worry of developing brain disease increases test willingness (13, 20, 39, 40, 42).

On the other hand, we found that respondents with education and/or employment in healthcare were less interested in testing their risk of brain disease than those without. We can only speculate that health care professionals are less interested in testing because they are more aware of the limitations of current predictive tests. Relatedly, studies find that knowledge of medical testing, such as understanding the inherent prognostic uncertainty and limited clinical validity of predictive tests, reduces the motivation for brain-related testing (27, 39, 41), such that more knowledge can sometimes make people more skeptical. Previous studies are nevertheless highly inconsistent on the relative effect of various sociodemographic factors on testing interest (17, 19, 20, 35). Due to the non-representativeness of our survey sample, the sociodemographic variations in brain health test interest found here should be explored further in future studies.

TABLE 5   Test criteria.

Variable	Characteristics	Accurate			Affordable			Subsidized		
		%	OR	99% CI	%	OR	99%CI	%	OR	99%CI
Gender	Women	83.6			48.0			47.6		
	Men	81.2	0.84	0.77–0.92	51.2	1.14	1.06–1.22	43.4	0.84	0.79–0.90
	Other/Undisclosed	76.3	0.63	0.37–1.07	55.7	1.36	0.86–2.15	46.6	0.96	0.61–1.51
Age	>60 years	84.8			48.1			44.4		
	41–60 years	82.7	0.85	0.78–0.94	46.9	0.95	0.89–1.02	47.5	1.13	1.06–1.21
	≤40 years	77.9	0.63	0.56–0.71	56.2	1.39	1.27–1.52	49.6	1.23	1.13–1.35
Education	Higher education	83.4			49.2			44.7		
	Lower education	81.8	0.89	0.82–0.98	48.5	0.97	0.91–1.04	50.2	1.25	1.17–1.33
Cognitive health	Average or above	83.0			49.0			46.1		
	Below average	81.1	0.88	0.74–1.04	49.4	1.02	0.89–1.16	52.1	1.27	1.12–1.45
Mental health	Average or above	83.1			48.7			45.8		
	Below average	81.4	0.89	0.79–1.00	51.0	1.10	1.00–1.20	50.6	1.21	1.10–1.33
Caregiver exp.	No	81.2			48.9			47.5		
	Yes	84.8	1.29	1.19–1.41	49.0	1.00	0.94–1.07	45.2	0.91	0.85–0.97
Illness experience	No	82.9			50.2			44.2		
	Yes	82.9	1.00	0.92–1.09	47.1	0.88	0.83–0.94	49.7	1.24	1.17–1.33
Brain research exp.	No	80.1			48.2			48.4		
	Yes	86.7	1.62	1.49–1.77	50.1	1.08	1.01–1.15	43.8	0.83	0.78–0.88
Health care exp.	No	82.2			49.4			45.8		
	Yes	84.0	1.13	1.04–1.24	48.3	0.96	0.90–1.02	47.5	1.07	1.00–1.14

Variable	Characteristics	Painless			Quick to take			Offered online		
		%	OR	99% CI	%	OR	99% CI	%	OR	99%CI
Gender	Women	35.6			28.8			27.5		
	Men	33.9	0.93	0.86–1.00	33.0	1.22	1.13–1.31	28.9	1.07	0.99–1.16
	Other/Undisclosed	41.2	1.27	0.80–2.01	20.6	0.64	0.37–1.12	21.4	0.72	0.41–1.25
Age	>60 years	31.4			30.3			32.0		
	41–60 years	36.1	1.23	1.15–1.32	31.2	1.04	0.97–1.12	26.2	0.76	0.70–0.81
	≤40 years	43.7	1.69	1.55–1.86	26.3	0.82	0.74–0.90	19.7	0.52	0.47–0.58
Education	Higher education	35.6			29.6			27.6		
	Lower education	34.1	0.94	0.87–1.00	30.8	1.06	0.98–1.14	28.3	1.04	0.96–1.12
Cognitive health	Average or above	35.5			30.3			27.6		
	Below average	30.0	0.78	0.67–0.90	25.7	0.80	0.69–0.93	31.5	1.21	1.05–1.39
Mental health	Average or above	35.1			30.6			28.3		
	Below average	35.4	1.01	0.92–1.11	26.3	0.81	0.73–0.90	25.1	0.85	0.76–0.94
Caregiver exp.	No	36.9			30.0			27.4		
	Yes	33.1	0.85	0.79–0.90	29.9	1.00	0.93–1.07	28.3	1.05	0.98–1.12
Illness experience	No	36.1			30.5			27.7		
	Yes	33.8	0.90	0.85–0.97	29.3	0.94	0.88–1.01	28.0	1.02	0.95–1.09
Brain research exp.	No	35.9			31.2			27.0		
	Yes	34.2	0.93	0.87–0.99	28.4	0.87	0.82–0.94	28.9	1.10	1.02–1.17
Health care exp.	No	36.3			29.8			28.4		
	Yes	33.4	0.88	0.82–0.94	30.3	1.02	0.95–1.09	26.9	0.93	0.87–1.00

(Continued)

TABLE 5   (Continued)

Variable	Characteristics	Other			%	OR	99% CI	%	OR	99%CI
		%	OR	99% CI						
Gender	Women	5.3								
	Men	5.1	0.97	0.83–1.14						
	Other/Undisclosed	6.9	1.32	0.54–3.24						
Age	>60 years	5.1								
	41–60 years	5.5	1.08	0.93–1.26						
	≤40 years	5.1	1.00	0.81–1.22						
Education	Higher education	6.1								
	Lower education	3.5	0.56	0.47–0.67						
Cognitive health	Average or above	5.2								
	Below average	5.5	1.05	0.79–1.40						
Mental health	Average or above	5.1								
	Below average	6.4	1.27	1.05–1.54						
Caregiver exp.	No	4.5								
	Yes	6.1	1.40	1.22–1.61						
Illness experience	No	4.7								
	Yes	6.1	1.31	1.14–1.51						
Brain research exp.	No	4.8								
	Yes	5.8	1.22	1.06–1.40						
Health care exp.	No	5.0								
	Yes	5.7	1.15	1.00–1.33						

% Indicates the proportion of participants selecting each characteristic. OR, Odds ratio; CI, Confidence interval.

Motivations for brain health testing

An important contribution of this study was not only to investigate people's willingness to test their brain health, but to give insight into *why* people would be willing to do so. We found that the most important motivation for testing for brain disease was to respond if they were found to be at risk, for example through lifestyle changes. This finding concurs with studies that have shown how people are most inclined to change behavior if they are personally afflicted by brain disease or cognitive decline (8). However, while a few studies find that people alter their behavior after receiving brain health related test results, such as supplements intake and other lifestyle changes (43), most studies fail to identify significant behavioral changes (26, 44), commonly known as the intention-behavior gap (45).

Another central motivation for testing among our respondents was gaining information about personal brain health, either of personal risk of developing brain disease or of personal cognitive and mental condition, even for diseases that cannot be treated or prevented. Other studies concur on the central importance for consumers of obtaining personal information, even non-medical information, from brain-related tests (37, 42). Similarly, studies find that knowledge about personal risk of disease is valued for planning future care, healthcare decisions and late-life decisions (39, 41). Studies have

also found that anticipation of last stages in life, and accessing healthcare, can be central motivations for undertaking testing for brain diseases (17, 20).

For the very few respondents in our study who were certain they did not want to take a brain health test, the primary motivation was not wanting to know about untreatable and/or unpreventable diseases, and not wanting to worry about something that might not happen. This supports previous research that dementia-worry can prevent some people from taking brain health tests all together (13, 20). On the whole however, our findings strengthen the notion that lay empowerment through information can be an important outcome of tests for brain disease risk.

Premises for brain health testing

Of all the presented criteria, the most important characteristic of a brain health test was accuracy of results. Similarly, other studies have found that the willingness to take a brain health test is partly dependent on the validity of test results (27, 39, 41). Other central criteria were economic accessibility, either through affordable prices or subsidies. In our study cost-related criteria were more important to young respondents

(40 years and below) and to respondents with low education levels and poor self-rated health.

Study limitations

This study has several limitations. First, the survey departed from a real-life scenario by asking respondents to imagine an unspecified and hypothetical test for brain disease that is currently unavailable. The respondents were not given the type of information that those who undergo real-life predictive testing in genetics must have before they undergo tests, such as for early detection of Alzheimer's for example. Other studies have shown that the willingness to undertake hypothetical tests is greater than actual test willingness when such tests are developed (39). Secondly, the respondents in this survey are unrepresentative of the general population because many were conveniently recruited via brain research organizations, institutes and research networks connected to the Lifebrain project. In line with most other relevant studies, respondents are more likely to be female, above middle age and have higher education. Moreover, in this study close to six of 10 had been recruited via brain research registries, close to half had experience with taking care of family members with brain disease, and about four out of 10 respondents had an education or employment in healthcare or had participated in brain research. Most of the respondents were in Europe, largely due to the sampling procedure and the European-based survey stakeholders (12, 31). These sociodemographic and individual characteristics may thus be due to self-selection bias and not give a true reflection of the general public's perceptions of brain health at large.

To further probe the effect of self-selection, we compared participants recruited through research registers and those who responded independently from the same countries. As expected, a larger proportion of the registry participants had taken part in brain research, and the more ostensibly respondents were engaged with brain health, the more they were likely to want to take a hypothetical brain health test. Even the "non-organised" participants who were not part of a research registry, had a large proportion of brain research participants (>25%)—more than one would expect in the general population. Both groups—those recruited through registers and the "non-organised"—were mostly highly educated, middle-aged, or older, and female, and therefore not representative of the general population. Despite this selectivity, the respondents were also people who had access to the internet and an interest in the topic, as well as the motivation to spend time in answering questions anonymously, without any further financial or other external motivation. The respondents were sufficiently interested in completing the questionnaire on their own initiative, and they therefore represent the stratum of society that is more informed

about brain health and also likely politically more engaged than the average citizen.

Conclusions and implications for future policy and research

Despite a self-selective sample with e.g., a large proportion of higher educated female respondents already interested in brain health, we believe this study provides several key insights that may be relevant for health authorities and policy makers, as interested citizens are likely to influence public opinion disproportionately. Firstly, we find that the vast majority of respondents wanted to take a simple hypothetical test to detect risk of brain disease. Test interest was high among respondents with personal experience of illness or of taking care of next of kin with brain disease. Given the expected increase in people with personal or family-related experience in brain diseases (3) our results indicate significant public demand for tests for brain diseases in the years to come.

Demand for personal information

Importantly, our results also show that for many respondents, obtaining personal brain health information was by itself a goal, regardless of preventative opportunities. While expressed interest in testing does not necessarily translate into actual testing behavior, this might change as less invasive and more accessible tests are becoming available. Studies have shown that the availability of high-quality information on the limitations of medical tests can adjust public expectations and thereby reduce the willingness to undergo testing. Relatedly, we find that respondents with experience and/or education in health care were less interested in brain health testing than other respondents. Studies also indicate the importance of access to high quality information after receiving test results to limit adverse reactions. A key task for both providers of medical tests and health authorities is hence to increase public education on the limitations and implications of medical testing and thoughtful communication of test results.

Motivations for behavioral change

Secondly, we find that most of the respondents indicate that a key motivational factor for testing for brain disease is changing their lifestyle. While research shows that intention to change behavior increases the likelihood of doing so, people generally do not change their behavior after receiving test results, despite their intentions to do so (21). Test results can also potentially reduce motivation to change behavior (21) or

inspire changes that are undocumented and not necessarily beneficial (40, 43). Nevertheless, thoughtful communication of test results, combined with personalized recommendations of evidence-based interventions, can increase the likelihood of behavioral change (21). A qualitative study for instance suggests that access to high-quality information on recommended activities to strengthen brain health can narrow the intention-behavior gap by facilitating long-term behavioral changes (42). Similarly, an Australian study found that both intentions and actions to improve brain health were associated with knowledge about dementia risk reduction (15). A pilot study of the GBHS found that personalized advice should also incorporate individual differences of motivations, triggers and capacities for lifestyle changes (13). Consequently, a second central task for health authorities should be to provide easily accessible public information on recommended behavioral changes to optimize brain health and reduce risk of developing brain disease.

Increased pressures on public health systems

Other central motivational factors for undertaking testing were seeking professional help and treatment if found to be necessary. This finding suggests that future public demand for professional follow up could be significant should tests for brain disease risk become widely available to the general public, in particular since risk factors are also present in people who never develop brain disease (6, 25). Widespread public brain health testing could hence both overwhelm the health care system and result in unnecessary and potentially harmful overtreatment. Given that commercial tests are often provided outside a framework of personal feedback and follow-up, the provision of high-quality information on medical testing and lifestyle changes could also help mitigate such unwanted consequences.

Future directions

In sum, considering the increasing amount of consumer tests entering the market, paired with optimistic, popularized representations of medical testing by the media, there is a need to foster realistic public expectations of brain health testing. Our study suggests a critical role of public authorities to educate the public on brain health testing and the provision of public brain health interventions and activities. Recognizing the difficulty of succeeding with lifestyle changes, we furthermore call for more research into factors that facilitate behavioral change for looking after ones' brain health. At the same time, public perspectives of brain health are evolving, and future research should therefore repeat this kind of survey at regular intervals to chart changes

in perceptions, also in other parts of the world and in different segments of the population.

Data availability statement

The data is publicly available with a CC-BY licence through GItHub as a tab-separated file or as an R data package, https://github.com/Lifebrain/gbhs. All source materials for data retrieval, cleanup, modelling and visualisation is also contained in the same repository. All these materials can also be found with their doi: 10.5281/zenodo.7116985.

Ethics statement

The studies involving human participants were reviewed and approved by Regional Committees for Medical and Health Research Ethics in Norway (2017/653 REK SørØst B). The survey was also approved by the University of Oxford Medical Sciences Interdivisional Research Ethics Committee (R67364/RE001) and the Medical Ethics Review Committee of VU University Medical Centre in the Netherlands for permission to disseminate the survey. The patients/participants provided their written informed consent to participate in this study.

Author contributions

RC and NF drafted and finalized the manuscript. IB-L led the study. IB-L, AM, BF, SS, CS-P, CD, WB, EZ, DB-F, PG, LN, KM, SD, and KW conceived the study and developed the survey. RC, IB-L, AM, BF, KE, EZ, CD, WB, DB-F, CS-P, and KW were involved in data collection and analysis. AM, EZ, and KE helped with the core statistical analysis. RC, NF, IB-L, KE, BF, TR, CD, SS, WB, CS-P, DB-F, PG, AF, UL, KM, and KW substantively revised the manuscript prior to submission. All authors contributed to the article and approved the submitted version.

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Conflict of interest

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

Publisher's note

Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpubh.2022.998302/full#supplementary-material

SUPPLEMENTARY MATERIAL 1
Binary and continuous outcome models, and descriptive outcomes of sub-questions with Odds Ratios and Confidence Intervals.

References

1. National Institute on Aging. *Cognitive Health and Older Adults*. National Institute on Aging (2022). Available online at: https://www.nia.nih.gov/health/cognitive-health-and-older-adults (accessed May 7, 2022).

2. World Health Organization. *Optimizing Brain Health Across the Life Course*: *WHO Position Paper*. Geneva: World Health Organization (2022).

3. Wang Y, Pan Y, Li H. What is brain health and why is it important? *BMJ*. (2020) 371:m3683. doi: 10.1136/bmj.m3683

4. Hachinski V, Avan A, Gilliland J, Oveisgharan S. A new definition of brain health. *Lancet Neurol*. (2021) 20:335–6. doi: 10.1016/S1474-4422(21)00102-2

5. Alzheimer's Disease International. *World Alzheimer Report 2018*. London (2018).

6. Livingston G, Huntley J, Sommerlad A, Ames D, Ballard C, Banerjee S, et al. Dementia prevention, intervention, and care: 2020 report of the lancet commission. *Lancet*. (2020) 396:413–46. doi: 10.1016/s0140-6736(20)30367-6

7. Maugui613 F, Trejo JL, Andjus P, Vergara C, Pochet R. Ten priorities for national brain and mental health plans. *Croat Med J*. (2019) 60:152–5. doi: 10.3325/cmj.2019.60.152

8. Skufca L. *Survey on Brain Health*. Washington, DC: AARP Research (2015).

9. Brain Health Scotland. *Brain Health Survey 2020*. Ipsos MORI (2020).

10. Fredheim NAG LI, Friedman B, Carver RB. *How to Promote Citizens' Brain Health? Insights From the Global Brain Health Survey on Citizens Perceptions of Brain Health Interventions*. University of Oslo (2021).

11. Carver RB, Fredheim NAG, Budin-Ljosne I, Friedman BB. What *Motivates People to Look After Their Brain Health? Insights From the Global Brain Health Survey*. University of Oslo (2022).

12. Budin-Ljty of Osloealth Surveyhat sne I, Friedman BB. What rain Health Inte, et al. Public perceptions of brain health: an international, online cross-sectional survey. *BMJ Open*. (2022) 12:e057999. doi: 10.1136/bmjopen-2021-057999

13. Friedman BB, Suri S, Solcross-lth Intenteealth Inteealth InteIntea, et al. Are people ready for personalized brain health? Perspectives of research participants in the Lifebrain Consortium. *Gerontologist*. (2020) 60:1050–9. doi: 10.1093/geront/gnz155

14. Tomat N, Perovnik M, Vidmar G, van Midden V, Fabjan S, Hawlina H, et al. Lay public view of neuroscience and science-based brain health recommendations in Slovenia. *Front Public Health*. (2021) 9:690421. doi: 10.3389/fpubh.2021.690421

15. Smith BJ, Ali S, Quach H. The motivation and actions of Australians concerning brain health and dementia risk reduction. *Health Promot J Austr*. (2015) 26:115–21. doi: 10.1071/he14111

16. Condit CM. Public attitudes and beliefs about genetics. *Annu Rev Genomics Hum Genet*. (2010) 11:339–59. doi: 10.1146/annurev-genom-082509-141740

17. Vermeulen E, Henneman L, van El CG, Cornel MC. Public attitudes towards preventive genomics and personal interest in genetic testing to prevent disease: a survey study. *Eur J Public Health*. (2014) 24:768–75. doi: 10.1093/eurpub/ckt143

18. Caselli RJ, Langbaum J, Marchant GE, Lindor RA, Hunt KS, Henslin BR, et al. Public perceptions of presymptomatic testing for Alzheimer disease. *Mayo Clin Proc*. (2014) 89:1389–96. doi: 10.1016/j.mayocp.2014.05.016

19. Wikler EM, Blendon RJ, Benson JM. Would you want to know? Public attitudes on early diagnostic testing for Alzheimer ondisease. *Alzheimer on ea Ther*. (2013) 5:43. doi: 10.1186/alzrt206

20. Alzheimer's Research UK. *Dementia Attitudes Monitor Wave 2* (2021).

21. Bubela TM, Caulfield TA. Do the print media "Hype" genetic research? A comparison of newspaper stories and peer-reviewed research papers. *Cmaj*. (2004) 170:1399–407. doi: 10.1503/cmaj.1030762

22. U.S. Food & Drug Administration. *FDA Permits Marketing for New Test to Improve Diagnosis of Alzheimer's Disease*. (2022). Available online at: https://www.fda.gov/news-events/press-announcements/fda-permits-marketing-new-test-improve-diagnosis-alzheimers-disease (accessed April 5, 2022).

23. Holen T, Norheim F, Gundersen TE, Mitry P, Linseisen J, Iversen PO, et al. Biomarkers for nutrient intake with focus on alternative sampling techniques. *Genes Nutr*. (2016) 11:12. doi: 10.1186/s12263-016-0527-1

24. Paulsen JS, Nance M, Kim JI, Carlozzi NE, Panegyres PK, Erwin C, et al. A review of quality of life after predictive testing for and earlier identification of neurodegenerative diseases. *Prog Neurobiol*. (2013) 110:2–28. doi: 10.1016/j.pneurobio.2013.08.003

25. Livingston G, Sommerlad A, Orgeta V, Costafreda SG, Huntley J, Ames D, et al. Dementia prevention, intervention, and care. *Lancet*. (2017) 390:2673–734. doi: 10.1016/s0140-6736(17)31363-6

26. Marteau TM, Lerman C. Genetic risk and behavioural change. *BMJ*. (2001) 322:1056–9. doi: 10.1136/bmj.322.7293.1056

27. Milne R, Diaz A, Badger S, Bunnik E, Fauria K, Wells K. At, with and beyond risk: expectations of living with the possibility of future dementia. *Sociol Health Illn*. (2018) 40:969–87. doi: 10.1111/1467-9566.12731

28. Goldman JS, Hahn SE, Catania JW, LaRusse-Eckert S, Butson MB, Rumbaugh M, et al. Genetic counseling and testing for Alzheimer disease: joint practice guidelines of the American College of Medical Genetics and the National Society of Genetic Counselors. *Genet Med*. (2011) 13:597–605. doi: 10.1097/GIM.0b013e31821d69b8

29. Phillips KA, Deverka PA, Hooker GW, Douglas MP. Genetic test availability and spending: where are we now? Where are we going? *Health Affairs*. (2018) 37:710–6. doi: 10.1377/hlthaff.2017.1427

30. O'Keeffe M, Nickel B, Dakin T, Maher CG, Albarqouni L, McCaffery K, et al. Journalists' views on media coverage of medical tests and overdiagnosis: a qualitative study. *BMJ Open*. (2021) 11:e043991. doi: 10.1136/bmjopen-2020-043991

31. Budin-Ljosne I, Friedman BB, Suri S, Sole-Padulles C, Duzel S, Drevon CA, et al. The global brain health survey: development of a multi-language survey of public views on brain health. *Front Public Health*. (2020) 8:387. doi: 10.3389/fpubh.2020.00387

32. Walhovd KB, Fjell AM, Westerhausen R, Nyberg L, Ebmeier KP, Lindenberger U, et al. Healthy minds 0-100 years: optimising the use of European brain imaging cohorts ("Lifebrain"). *Eur Psychiatry*. (2018) 50:47–56. doi: 10.1016/j.eurpsy.2017.12.006

33. R Core Team. *R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing* (2021).

34. Neumann PJ, Cohen JT, Hammitt JK, Concannon TW, Auerbach HR, Fang C, et al. Willingness-to-pay for predictive tests with no immediate treatment implications: a survey of us residents. *Health Econ*. (2012) 21:238–51. doi: 10.1002/hec.1704

35. Luck T, Luppa M, Sieber J, Schomerus G, Werner P, Konig HH, et al. Attitudes of the German general population toward early diagnosis of dementia–results of a representative telephone survey. *PLoS ONE*. (2012) 7:e50792. doi: 10.1371/journal.pone.0050792

36. Roberts JS, Ostergren J. Direct-to-consumer genetic testing and personal genomics services: a review of recent empirical studies. *Curr Genet Med Rep.* (2013) 1:182–200. doi: 10.1007/s40142-013-0018-2

37. Roberts JS, Gornick MC, Carere DA, Uhlmann WR, Ruffin MT, Green RC. Direct-to-consumer genetic testing: user motivations, decision making, and perceived utility of results. *Public Health Genomics.* (2017) 20:36–45. doi: 10.1159/000455006

38. Bond J, Graham N, Padovani A, Mackell J, Knox S, Atkinson J. Screening for cognitive impairment, Alzheimer's disease and other dementias: opinions of European caregivers, payors, physicians and the general public. *J Nutr Health Aging.* (2010) 14:558–62. doi: 10.1007/s12603-010-0268-6

39. Roberts JS. Anticipating response to predictive genetic testing for Alzheimer's disease: a survey of first-degree relatives. *Gerontologist.* (2000) 40:43–52. doi: 10.1093/geront/40.1.43

40. Cutler SJ, Hodgson LG. To test or not to test: interest in genetic testing for Alzheimer's disease among middle-aged adults. *Am J Alzheimer gene Other Dementias.* (2003) 18:9–20. doi: 10.1177/153331750301800106

41. Gooblar J, Roe CM, Selsor NJ, Gabel MJ, Morris JC. Attitudes of research participants and the general public regarding disclosure of Alzheimer disease research results. *JAMA Neurol.* (2015) 72:1484–90. doi: 10.1001/jamaneurol.2015.2875

42. Kopits IM, Chen C, Roberts JS, Uhlmann W, Green RC. Willingness to pay for genetic testing for Alzheimer's disease: a measure of personal utility. *Genet Test Mol Biomarkers.* (2011) 15:871–5. doi: 10.1089/gtmb.2011.0028

43. Vernarelli JA. Impact of genetic risk assessment on nutrition-related lifestyle behaviours. *Proc Nutr Soc.* (2013) 72:153–9. doi: 10.1017/s0029665112002741

44. Hollands GJ, French DP, Griffin SJ, Prevost AT, Sutton S, King S, et al. The impact of communicating genetic risks of disease on risk-reducing health behaviour: systematic review with meta-analysis. *BMJ.* (2016) 352:i1102. doi: 10.1136/bmj.i1102

45. Faries MD, Why we don't "Just Do It": understanding the intention-behavior gap in lifestyle medicine. *Am J Lifestyle Med.* (2016) 10:322–9. doi: 10.1177/1559827616638017

How public confidence was established during the COVID-19 pandemic by Chinese media: A corpus-based discursive news value analysis

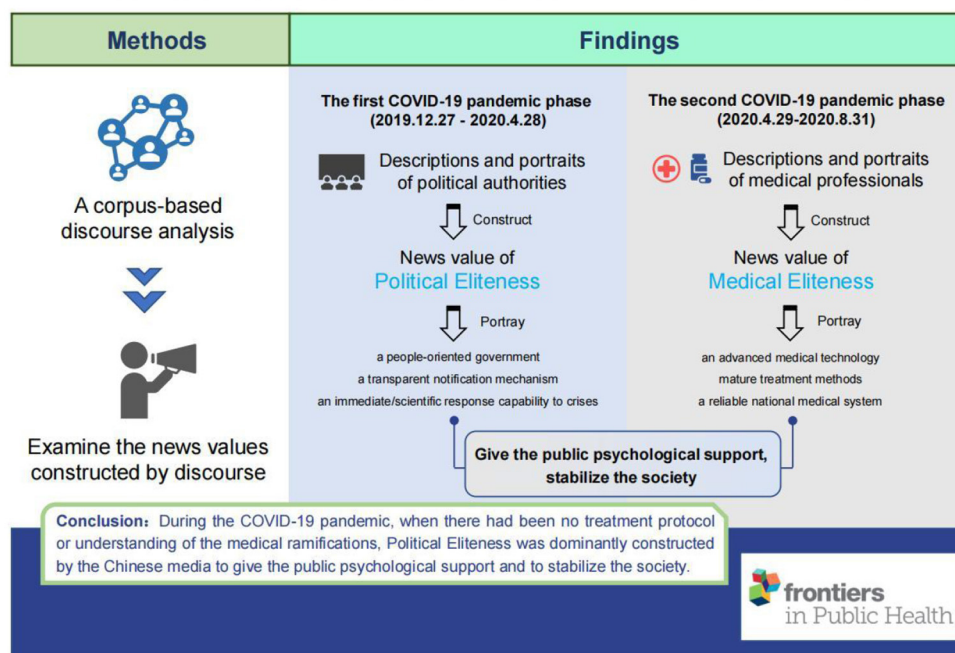Cheng Chen[1] and Renping Liu[2]*

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During the COVID-19 pandemic, Chinese media played a significant role in dispelling the public panic, establishing the public confidence and stabilizing the society during the COVID-19 pandemic. This corpus-based discourse study explored the discursive construction of news values by Chinese media to reveal how the COVID-19 pandemic was packaged and sold to the public to establish confidence in the news reporting. Adopting corpus linguistic method and the Discursive news values analysis (DNVA) framework, this study examines news values through key words, news quotations, and images in the Chinese domestic mainstream media (http://www.people.com.cn/) during two different phases of the pandemic. The results show that during the first pandemic phase (2019.12.27−2020.4.28) when there had been no treatment protocol or understanding of the medical ramifications, Chinese media dominantly constructed political Eliteness through multimodal resources to portray a people-oriented government, a transparent notification mechanism and an immediate response capability to crises, and to give the public psychological support and to cultivate positive attitudes toward the government's policy. This news reporting way exposes the universal trust of Chinese society in the political authorities. During the second phase (2020.4.29−2020.8.31) when the cognition about the COVID-19 virus had been greatly improved and more medical treatment and prevention methods had been developed, the political Eliteness was replaced by medical Eliteness which was more vital to people's safety during the health crisis. We propose actionable recommendations for scholars to use this in-depth DNVA framework to examine the social trend of thoughts during major public health crisis.

KEYWORDS

COVID-19 pandemic, Chinese media, news values, discourse analysis, public confidence

How was the COVID-19 pandemic packaged and sold by the Chinese media to the domestic public to establish social confidence?

Methods	Findings	

A corpus-based discourse analysis

Examine the news values constructed by discourse

The first COVID-19 pandemic phase (2019.12.27 - 2020.4.28)

Descriptions and portraits of political authorities

Construct

News value of Political Eliteness

Portray

a people-oriented government
a transparent notification mechanism
an immediate/scientific response capability to crises

The second COVID-19 pandemic phase (2020.4.29-2020.8.31)

Descriptions and portraits of medical professionals

Construct

News value of Medical Eliteness

Portray

an advanced medical technology
mature treatment methods
a reliable national medical system

Give the public psychological support, stabilize the society

Conclusion: During the COVID-19 pandemic, when there had been no treatment protocol or understanding of the medical ramifications, Political Eliteness was dominantly constructed by the Chinese media to give the public psychological support and to stabilize the society.

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GRAPHICAL ABSTRACT

Introduction

When the COVID-19 pandemic first broke out in the city of Wuhan in China, there was no understanding of the new virus and no treatment protocol. The exponentially increasing patients, the intensive exposure to death, and the breakdown of the medical system caused a great panic among the Chinese public. With the frequent home quarantine and social isolation, the information flow had been cut down and the Chinese-government-dominated mainstream media became the primary channel for the public to learn about the epidemic situation and understand the COVID-19 prevention and treatment methods. The previous studies demonstrated the way in which the health belief education on COVID-19 has directly resulted in the public's mental health concerns [see (1–3)]. The social effect exerted by health belief education is especially strong when it is done through media's reporting and guidance. Moreover, Su et al. (4) examined ways through which legacy media reports on COVID-19 and how social media-based infodemics can result in mental health concerns, and found that media resources should focus on the core issue of how to slow or stop COVID-19 transmission effectively.

During the COVID-19 pandemics in China, as Chinese president Xi Jinping (5) claimed, with strategic ways of information dissemination, Chinese media played a significant role in dispelling the public panic, establishing the public confidence and stabilizing the society. The current study aims to examine how the Chinese media established public confidence by news reporting during different phases of the COVID-19 pandemic.

News values are a set of criteria that determine the selection of what and how is being reported as news (6–8). The examination of news values helps reveal how the media packaged the social event and sold its intended values to the audiences (5). Exposure of the hidden news values within news reports is the very concern of Discursive news value analysis (DNVA), which focuses on how newsworthiness is constructed through multimodal news resources. In this article, we adopt the DNVA method to explore the different news values constructed by Chinese mainstream outlets around the COVID-19 epidemic during different phases (based on the timeline publicized by the Chinese government), as well as the discursive way that the news values are established and sold to the audiences by the Chinese media.

Based on the previous studies (7–9), Eliteness comprises the prominent news values frequently constructed by media. It has been defined as high status or fame (9), which is usually constructed by various status markers such as professional figures and terminology, high-status identities, and their accent/sociolect, recognized names, descriptions

of achievement/fame, recognizable key figures, the specialist equipment associated with elite professions, etc. (9). This study focuses on analyzing the construction ways of Eliteness in the Chinese media reporting on COVID-19 pandemic, trying to explore the special presentations of Eliteness and improving the definitions of Eliteness. We hope this study will offer a new investigation of DNVA in COVID-19 news discourse and prove the application potentials of DNVA framework in public health crisis.

News values and a discursive approach to news values

Emanating from journalism and communications research, the concept of "news values" has been predominantly identified as the impetus for the selection of news content (story/event) (7, 10). For example, Palmer (7) defined news values as aspects of an event which is in accordance with the timeliness, interest, importance, etc. Harrison (11) specified that news events intrinsically carrying news value as "events are deemed to be self evidently newsworthy". By contrast, linguists such as Bell (8), Richardson (12), Baker et al. (13) expanded the scope of news values beyond the content-based perspective, and interpreted it as a discourse construction process. For example, Bell (8, 14) specified the controlling roles of the news values in constructing news discourses, and also indicated that the language is frequently used to enhance and maximize news values.

The aforementioned journalistic and linguistic perspectives were amalgamated by Bednarek and Caple (15–17), who advanced a discursive approach that portrays news values in two interrelated dimensions. The first one holds that news values are constructed through discourse, which encompasses any discourse that plays a part in the news process, for example, verbal and visual input material, interviews, press releases, etc. (17, 18). Second, news values are defined as a quality of texts which self-expresses through a wide range of semiotic devices (language, image, typography, layout, sound, etc.) (17). Hence, the discursive approach to news values [commonly known as "Discursive news values analysis (DNVA)"] entails the investigation of the multiple semiotic choices utilized in the construction of news discourse in the context of their roles in establishing news values (18). With its capability for systematic analysis of news value construction through a series of multimodal resources, the DNVA framework helps researchers gain a fuller understanding of how the news is forged (19). Since its introduction a decade ago, DNVA has been progressively developed by expanding the scope of resource types that construct news values, from written language (19) to multimodal devices (15, 20, 21). Accordingly, the categories and definitions of news values have also been constantly updated and improved. Whilst they had formerly been limited to 7

categories that solely centered on linguistic devices (15), now they have increased to 11 categories with a broader purview, including not only linguistic but also visual signs. Recently a cross-cultural perspective is adopted and several news values have been redefined and linked with publication time and publication's target audience (9, 22). For example, Proximity, originally defined as "the geographical or cultural nearness of an event or issue" (18), has been redefined as "geographically or culturally near the target audience" (22).

With its essential focus on newsworthiness analysis, the DNVA framework also covers the examination of the whole news communication process, including the motivations behind maximizing news value (e.g., social powers, potential value of events, journalistic value), the construction of news reporting, and the social effect of the news reporting, which is in turn determined by the newsworthiness. For example, Caple et al. (9) interpreted national days in news reporting as closely tied to the history of a nation and the discursive construction of national identity, and estimated the social reaction of the news reporting.

Taking a further step from the "manually-conducted" DNVA (through close reading of relevant texts), researchers [e.g., (22, 23)] have successfully paved the way for the application of corpus-linguistic methodology in DNVA through several case studies. Corpus techniques have been proved to allow researchers to examine the most salient linguistic devices in each corpus which have the potential to construct marked news values, and to provide insights into "how happenings are sold to audiences as newsworthy" (17).

Adapting discursive news values analysis to Chinese health crisis

As the previous studies have demonstrated, the broadcast of the exact information during the COVID-19 pandemic greatly helps decrease the public fear, stabilize society and improve the medical prevention and treatment [see (24, 25)]. For example, Rahmat et al. (26) proceeded a questionnaire survey to medical students and found specific strategies from the government officials in information broadcast to address medical students' uncertainties and increase the adoption of technology amid the COVID-19 pandemic. Among the existing related studies, media discourse has been proved as the most influential tool to dominate various social factors. For example, Yoosefi Lebni et al. (27) examined how the COVID-19 pandemic affected economic, social, political, and cultural factors, and found that the media supported by the government greatly helped to build confidence among people, overcome their fear, anxiety, stress, and mental health problems. The function of the media was proved as prominently effective in the COVID-19 pandemic in China [e.g., (25, 28, 29)].

As DNVA has a powerful framework for systematic analysis of news value construction through multimodal resources, it

has been frequently adapted in exploring the way by which the media (or journalists) package a health crisis and the social effect of the news reporting, especially the COVID-19 pandemic (15). For example, Langbecker et al. (30) examined the news values construction by comparatively analyzing the journalistic coverage of the National Health System (SUS) by "Folha de São Paulo," and the National Health System (SNS) by "El Pais." Building on a discursive view on news values, Andersen et al. (31) outline how news values are discursively constructed through online news headlines on health topics from three Nordic countries, and examine how journalists construct their target audience discursively by imposing problems and projecting desires for action and change onto readers. Colak (32) analyzed the news values of social media regarding the term, COVID-19, with the phenomenological method. Trishchuk et al. (33) analyzes the newsworthiness of online media during the crisis caused by the coronavirus pandemic and highlights changes in the content of media platforms during the spread of the coronavirus pandemic.

Though DNVA has been primarily applied to Western-centric languages and contexts (9), variations in the construction of newsworthiness in the news reporting of Western and Chinese media have been more frequently compared in recent studies. For example, Zhang and Caple (23) examine news values in four news outlets from China, Britain, Australia and the United States in their English-language news reporting about the Chinese tennis player, Li Na. Caple et al. (9) present a cross-linguistic comparison of news values in "national day" reporting from China and Australia. However, these previous China-Western comparative studies were actually still Western-centric, as they focused on Western-interested stories [for example, the individualism of Li Na (23), the democracy of nationalism (9)] and aimed at exploring how Chinese newsworthiness deviates from Western values, instead of analyzing China's media communication in terms of Chinese stories. This study focused on analyzing Chinese news discourse and exploring the distinctive news process and the ideological forces that drive the Chinese media in reporting China's health crises. In this way, the present study makes the first attempt at a China-centric news story analysis.

Data and methods

Data

In this study, we adopt the COVID-19 pandemic phases categorized by Chinese national government which specifically describe the pandemic situations in China (We did not adopt the WTO phases as they portray the pandemic situations of the whole world). As reported by the National Health Commission of China, based on the affected area and the prevention and control mechanism, the COVID-19 pandemic in China can be divided into two general phases (34). The first phase is from December 27th, 2019 to April 28th, 2020 when the COVID-19 pandemic first occurred in the city of Wuhan, rapidly spread nationwide, and the emergency response was explored and launched. The second phase is after April 29th, 2020, in which the epidemic has been generally controlled and the regular prevention measures are being implemented. Therefore, this study established two Chinese news corpora to analyze the different news values constructed by Chinese media in different COVID-19 phases.

The world has become a global village and technology use has made it a smaller world through online media (35). This original study chose online news reporting from "*people.cn*" (http://www.people.com.cn/) to establish the corpus, which are the Chinese-government-dominated mainstream online newspapers and enjoy the widest domestic circulation with extensive readership. The Chinese word "新冠肺炎(COVID-19)" was used as the search term to retrieve Chinese news reports around the COVID-19 pandemic during the two periods: from December 27th, 2019 to April 28th, 2020 (the first phase); and from April 29th, 2020 to August 31th, 2020 (the second phase). Both of selected periods are equal in duration of time. For each period, 200 related news reports were collected in random to establish the corpus (the two corpora were marked as Corpus-Phase 1 and Corpus-Phase 2). Meanwhile, for retrieving the keyword lists of Corpus-Phase 1 and Corpus-Phase2, another 200 news reports with no specific theme before December 27th, 2019 (from August 26th, 2019 to December 26th, 2019) were collected as the reference corpus. The Chinese texts of all the three corpora have been annotated and segmented into Chinese words by the word segmentation tool "pkuseg (https://github.com/lancopku/PKUSeg-python)."

Considering that the news reports are usually of different lengths, which renders the two corpora uneven in word counts (Table 1), the analysis of this study is based on percentages instead of the total numbers, as the statistical techniques demonstrated in the previous studies (36, 37). As the present study is concerned with how news values are discursively

TABLE 1 The two corpora of Chinese media and Indian media.

Corpus	Corpus-phase 1 (2019.12.27-2020.4.28)	Corpus-phase 2 (2020.4.29-2020.8. 31)	Reference corpus (2019.8.26-2019.12.26)
The number of news reports	200	200	200
Total character count	276,844	279,648	119,190
The number of photographs	54	62	Not collected

constructed through both language and images, a total of 54 photographs associated with the verbal stories were collected in Corpus-Phase 1 and 62 photographs were collected in Corpus-Phase 2 (Table 1). As photographs of the two corpora are not equal in number, the analysis of the news values constructed by visual resources is also based on percentages, for ensuring the comparability.

Methods

This DNVA study combines corpus linguistic techniques to examine the news values construed: ① in keywords and their concordances, revealing the focus of the reporting (38); ② in the identities of the quoted speakers and the frequencies they have been quoted, reflecting the media's selection of the values delivered by these quotations (39); and ③ in the photographs illustrated with the news reports, offering insights into how "COVID-19" is presented to audiences visually (40). These techniques provide statistic support for analyzing the way that news values are constructed (41), including examining the "news actors," "happenings" and "issues" (15). The procedures of this study are comprised of four steps as follows.

First, the corpus analysis tool AntConc 3.5.8w was used to conduct the keywords analysis, helping ascertain which Chinese words demonstrate saliency in the two news corpora (Corpus-Phase 1 and Corpus-Phase 2), respectively. As keywords works as a "pointer" to the construction of certain news values (17), this focus revealed the news values established by the Chinese media and the discrepancies during different two COVID-19 Phases. The concordance lines of the keywords were further examined to better observe the way that the news values are actually constructed.

Second, we examined the quotations in the news discourse manually, including analyzing the identities of the quoted speakers and counting the frequencies of the quotations, to identify the values that the media intended to sell in selection of social voices (21).

Third, in order to determine the way in which news values are constructed in imagery, we labeled the photographs in terms of their camera techniques and content, which includes the visual participants, their activities, the circumstances where these activities take place, etc. (40). On the other hand, camera technique comprises "shutter speed (how fast), aperture (how much light), focal length (how much in focus), lens (how distorted/natural/condensed the shot), and angle (how high or low the angle)" (15).

Fourth, the features of the multimodal semiotic resources centered on the above three aspects have been further analyzed in the DNVA framework, to examine how they work together to emphasize the newsworthiness of the COVID-19 epidemic events. The 11 news value categories (42) were adopted as the criteria to define and interpret the news values, as these

11 categories define news values both for linguistic and visual resources (43). Moreover, the social effect of the news reporting upon the public around the COVID-19 epidemic has been further discussed based on the newsworthiness constructed by the Chinese media.

Findings and analysis

Keywords in reporting and the construction of news values

With AntConc 3.5.8w, these two Chinese corpora were compared reciprocally and two keywords lists were obtained, one with 46 words for Corpus-Phase1 and the other with 31 words for Corpus-Phase1 (see Table 2). These keywords were classified into different groups based on their semantic domain, by which it can be inferred what the pandemic event is mainly constructed as. The semantically categorized Chinese keywords, their English translations, the frequencies and the keyness statistics are listed in Table 2. The differences can be easily found in the two corpora.

The keywords of Corpus-Phase1 focus on depicting three aspects of semantic domains: ① the political leaders/institutions and their actions against the COVID-19 pandemic, ② the common citizens and their health, and ③ the war metaphors for the combat against COVID-19. The first semantic domain is mainly composed of the names of the political leaders (for example, 习近平 [Chinese President Xi Jinping], 李克强 [Chinese Premier Li Keqiang]), the leadership (for example, 领导小组 [leading group], 党中央 [the Central Committee of the CPC]) and the leaders' political actions (for example, 加强 [reinforce], 控制 [control], 指示 [instruct]), portraying the organizing, planning and supervising actions of the political leaders/institutions against the COVID-19 pandemic, consequently construing the news value of Eliteness (see EXAMPLE 1 and EXAMPLE 2).

Example 1

English translation: The National Health Commission will further reinforce the links between governmental departments and learn specific measures to jointly enhance epidemic prevention and control.

(*people.cn*, 2020-01-19)

Example 2

English translation: Chinese President Xi Jinping made important instructions on the COVID-19 pandemic, emphasizing that people's safety and health should be put first and the epidemic would be resolutely controlled. Chinese Premier Li Keqiang made concrete instructions.

(*people.cn*, 2020-01-20)

TABLE 2 The keywords in reporting of the COVID-19 pandemic during different phases by Chinese mainstream media.

Semantic domain	Corpus-phase 1	Corpus-phase 2	News value
Common citizens and their health	患者 (patient 225/137.57) 病例 (case of illness 74/53.37) 公共卫生 (public health 186/134.19) 生命安全 (safety 119/85.83) 身体健康 (health 115/82.95) 生活必需品 (daily necessities 50/36.06) 群众 (the citizens 351/78.43) 人民 (the people 468/58.41) 收治 (receive and cure 77/55.53) 救治 (treat and cure 293/192.27) 复工复产 (work resumption 201/145.02)	患者 (patient 232/138.77) 病例 (case of illness 116/81.78) 老年人 (old people 105/74.02) 救治 (treat and cure 126/73.08) 生命安全 (safety 56/39.47)	Personalisation
Political leaders/institutions and their actions	各级党委 (Party committees at all levels 100/57.21) 习近平 (President Xi Jinping 842/52.72) 李克强 (premier of the State Council 760/48.67) 领导 (leaders 210/40.57) 干部 (officials 168/32.11) 党中央 (the Central Committee of the CPC 269/26.96) 领导小组 (leading group 101/25.02) 加强 (reinforce 758/199.31) 保障 (guarantee 403/110.69) 联防联控 (Joint Prevention and Control Mechanism 148/106.76) 坚决 (resolute 253/87.27) 强调 (emphasize 348/87.04) 确保 (ensure 201/78.04) 统筹 (unified planning 200/74.31) 落实 (implementation 292/54.92) 抓好 (vigorously undertake 134/54.2) 加大 (enhance 75/54.09) 抓实 (accountability for actions 74/53.37) 全力 (spare no effort 114/52.69) 组织 (organize 230/49.73) 控制 (control 68/49.04) 指出 (point out 303/48.55) 指示 (instruct 59/25.69) 集中 (centralize 124/48.19) 部署 (deploy 250/48.15)		Eliteness
War metaphor	阻击战 (the battle for blocking the enemies 170/122.64) 打赢 (win the battle 196/93.01) 攻关 (storm a strategic pass 117/63.5) 斗争 (fight 115/57.49) 人民战争 (the people's war 66/47.6) 抗击 (beat back 65/46.87) 战胜 (triumph over 107/38.21) 总体战 (the battle by mobilizing all resources 53/38.22) 保卫战 (the battle for defense 38/27.4)	斗争 (fight 119 /58.33) 人民战争 (the people's war 36/25.37) 战胜 (triumph over 81/22.71) 战役 (the battle 36/25.37)	
Professional medical research and treatment	科学 (science 185/104.26) 科研 (scientific research 134/61.45)	病毒 (virus 193/136.1) 冷链 (cold train 183/129.04)	

(Continued)

TABLE 2 (Continued)

Semantic domain	Corpus-phase 1	Corpus-phase 2	News value
		中医药 (traditional Chinese medicine 151/106.47)	Eliteness
		核酸检测 (nucleic acid testing 148/104.35)	
		科学 (science 170/91.49)	
		常态化 (Normalization 123/77.51)	
		医疗 (medical treatment 208/62.16)	
		接种 (vaccinate 87/61.33)	
		发热 (fever 81/57.1)	
		隔离 (quarantine 81/57.1)	
		消毒 (sterilize 80/56.39)	
		口罩 (medical facemasks 75/52.87)	
		门诊 (section for outpatients 85/51.45)	
		中西医 (traditional Chinese medicine and western medicine 64/45.11)	
		预防 (prophylactic 64/45.11)	
		流调 (epidemiological investigation 37/26.08)	
		外防 (prevent the coronavirus from entering 39/27.49)	
		消杀 (sterilize 36/25.37)	
		重症 (patients in severe condition 36/25.37)	
		疫苗研发 (vaccine development 32/22.55)	
		医学观察 (medical observation 33/23.26)	
		疾控中心 (Center for Disease Control 33/23.26)	

The keywords of the second semantic domain mainly illustrate the identities of the common individuals (for example, 患者 [patient]) and the benefits that they can enjoy, such as medical care, necessities of life, convenient transportation (as shown in EXAMPLE 3 and EXAMPLE 4), construing the newsworthiness of Personalisation. The concordance lines further demonstrate that the individuals' identities and their benefits are usually illustrated in the political leaders' or political institutions' statements as the government's policies/plans are geared to benefit people. For example, the medical benefits offered to the patients illustrated in Example 3 were issued as a policy by "Li Keqiang (Chinese Premier)" in the leading group conference (see EXAMPLE 5); the daily supply offered for common citizens during the COVID-19 pandemic were promised by "the Ministry of Finance and the National Medical Insurance Administration" as an emergency notice (see EXAMPLE 6). Therefore, it can be argued that the establishment of Personalisation is accompanied by the construction of Eliteness.

Example 3

English translation: For ensuring that the patients diagnosed as COVID-19 infection can all afford to have the treatment, the Ministry of Finance and the National Medical

Insurance Administration jointly issued an emergency notice, proposing that the drugs and medical services for the diagnosis and treatment of COVID-19 infection can be temporarily included in the payment scope of medical insurance fund.

(*people.cn*, 2020-01-23)

Example 4

English translation: We should ensure the normal supply of daily necessities, coordinate and ensure the supply of vegetables in key epidemic areas, maintain smooth transportation, give priority and free access to vehicles carrying out emergency transportation tasks, ensure the key supply of coal, electricity, oil and gas, and make every effort to prevent and control the epidemic.

(*people.cn,* 2020-01-29)

Example 5

English translation: Li Keqiang, member of the Standing Committee of the Political Bureau of the CPC Central Committee, Premier of the State Council, and the leader of the central leading group for responding to the COVID-19 infection, presided over the leading group conference and pointed out: For ensuring that the patients diagnosed as

COVID-19 infection can all afford to have the treatment, the Ministry of Finance and the National Medical Insurance Administration jointly issued an emergency notice, proposing that the drugs and medical services for the diagnosis and treatment of COVID-19 infection can be temporarily included in the payment scope of medical insurance fund.

(*people.cn,* 2020-01-23)

Example 6

English translation: The Ministry of Finance and the National Medical Insurance Administration jointly issued an emergency notice: We should ensure the normal supply of daily necessities, coordinate and ensure the supply of vegetables in key epidemic areas, maintain smooth transportation, give priority and free access to vehicles carrying out emergency transportation tasks, ensure the key supply of coal, electricity, oil and gas, and make every effort to prevent and control the epidemic.

(*people.cn,* 2020-01-29)

The keywords as war metaphors compare the COVID-19 pandemic prevention and efforts with a battle, thereby overstating the lethality of the virus, emphasizing the emergency to eliminate the virus, and consequently enhancing the people's will to fight. In this way, the newsworthiness of superlativeness has been constructed. On the other side, the metaphor of war imbues the COVID-19 pandemic prevention and control with political hue, which is in accord with the dominant keywords on "Political leaders/institutions and their actions."

On top of the three main semantic domains discussed above, there are two keywords (科学[science] and 科研[scientific research]) conveying the abstract concepts for "professional medical research and treatment."

Comparatively, in Corpus-Phrase2, the keywords around "professional medical research and treatment" take the dominant semantic domain and express much more concrete medical concepts, such as 中医药 (traditional Chinese medicine), 流调 (epidemiological investigation), 疫苗研发 (vaccine development), etc. The concordance lines further show that these medical keywords are closely associated with medical elite professions; for example, the keyword "疫苗研发 (vaccine development)" occurred with an abundance of specialized/technical terminologies and the identities of medical experts, thus construing the news value of Eliteness (see EXAMPLE 7). Besides, Corpus-Phase 2 also contains keywords depicting "common citizens and their health" and "war metaphor," but is much less deficient in quantity and types than those of Corpus-Phase 1.

Example 7

English translation: Huang Luqi, an academician at the Chinese Academy of Engineering, specifically introduced that

"the scientific research team has always insisted on giving top priority to vaccine research and development, and is committed to developing safe, effective and accessible vaccines"; "We will always adhere to the scientific law and simultaneously promote the five technical routes of inactivated vaccine, recombinant protein vaccine, adenovirus vector vaccine, attenuated influenza virus vector vaccine and nucleic acid vaccine, so as to maximize the success rate of vaccine research and development.

(*people.cn*, 2020-07-31)

Generally speaking, during the two COVID-19 pandemic phases, the Chinese media dominantly constructed the news value of Eliteness, albeit in different ways. During the first phase, the Chinese media mainly establishes Eliteness through the authoritative identities of the political leaders/institutions and their actions (including the war concepts). It can be seen that when the pandemic first occurred and people had no understanding of the medical ramifications, the Chinese media made full use of the political authoritativeness to establish people's confidence and stabilize the society (the Eliteness which is constructed by political authorities is referred as Political Eliteness in the following part). Moreover, the news value of Personalisation has also been highlighted to establish the common people's positive attitude toward the government's policy; Superlativeness has been construed by war metaphor to create an atmosphere of emergency, which further reinforce people's confidence. In contrast, during the second phase when the cognition about COVID-19 virus had been greatly improved and more medical treatment and prevention methods had been developed (the Eliteness which is constructed by medial profession is referred as Medical Eliteness in the following part), the political Eliteness had been entirely replaced by the medical Eliteness with more technical terms and medical authoritative identities. In this way, people's confidence has been constructed by the reporting on the medical development.

News values constructed by quotations

As news has been defined as "what an authoritative source tells a journalist" (8), quotation is deemed as the most characteristic feature of news language (35, 44). The inclusion of external voices is of crucial interest in news discourse studies (23, 39, 45), and one of the major themes that the scholars are concerned with is the relations between quotation and social power, which were mainly found and interpreted in who gets quoted. For example, van Dijk (39) revealed that in European news discourse, minority groups were quoted much less than the whites, demonstrating the European media showed racial discrimination in reporting. Zhang and Caple (23) inferred the diplomatic relations between China and Japan in the summit meetings by

TABLE 3 The identities of the speakers and their concurrences in news quotations.

Media Identity of the speaker	Corpus-phase 1	Corpus-phase 2	News value
Political elites	**383 (99%)** Example: 习近平 (Xi Jinping, President of China) 孙春兰 (Sun Chunlan, Vice Premier of the State Council of China) 黄坤明(Huang Kunming, Deputy Head of Publicity Department of China) 李斌 (Li Bing, Deputy Director of the National Health Commission of China) 贺青华 (He Qinghua, the first-level inspector of the National Health Commission of China)	**8 (2%)** Example: 陈竺 (Chen Zhu, Vice Chairman of the Standing Committee of the National People's Congress) 何维 (He Wei, Vice President of Chinese People's Political Consultative Conference) 徐南平 (Xu Nanping, Vice Minister of Science and Technology Department)	
Professional medical elites	**3 (1%)** Example: 钟南山(Zhong Nanshan, a prominent Chinese expert in respiratory diseases)	**319 (98%)** Example: 蒋荣猛(Jiang Rongmeng, member of the NHC expert team) 张伯礼(Zhang Boli, academician of the Chinese Academy of Engineering) 黄璐琦(Huang Luqi, an academician of the Chinese Academy of Engineering) 曾益新(Zeng Yixin, deputy head of the National Health Commission of China) 赵丽君(Zhao Lijun, Vice Dean of Sichuan Friendship Hospital)	

Bold values indicate occurrences of the identity (proportion of the quotations).

comparing the different frequencies of the quotations from the Chinese and Japanese heads of State in international reporting. This research explores the identities of the quoted speakers and the frequencies they have been quoted, and demonstrates the newsworthiness constructed by the selection of these quotations.

Table 3 shows that the Chinese media reported the COVID-19 pandemic by frequently quoting from the voices made by two groups of people, including "Political elites" and "Professional medical elites" (only 5 instances at most for each identity are listed, due to space limit). The two groups of the speakers both indicate high social, professional or political identities, and so establish the news value of Eliteness. Corpus-Phase 1 dominantly quoted the words of "Political elites," expressing the governmental policies and plans for preventing and controlling the COVID-19 pandemic (see EXAMPLE 8 and EXAMPLE 9); Corpus-Phase 2 mainly cited the sayings of "Professional medical elites," specifying the medical prevention and professional treatment methods (see EXAMPLE 10 and EXAMPLE 11). The statistics of this part further verifies the results of the "Keyword part" that political Eliteness dominates the news reporting in the first phase of COVID-19, and medical Eliteness dominates the news reporting in the second phase of COVID-19.

Example 8

English translation: Sun Chunlan (Vice Premier of the State Council of China) stressed that it is necessary to strictly carry out the territorial responsibility system and the first diagnosis responsibility system, to search for the source of the disease, to block the source infection, to isolate and prevent the proliferation of the COVID-19 virus, to control the source of infection, to block the route of transmission, and to prevent internal proliferation and external export.

(*people.cn*, 2020-01-22)

Example 9

English translation: President Xi Jinping has made instructions on this regard, stressing the need to put people's lives and health on the first place, and to resolutely contain the spread of the epidemic.

(*people.cn*, 2020-01-21)

Example 10

English translation: "In the process of vaccination, the cases of mild fever are <0.1%, and the incidence of severe adverse
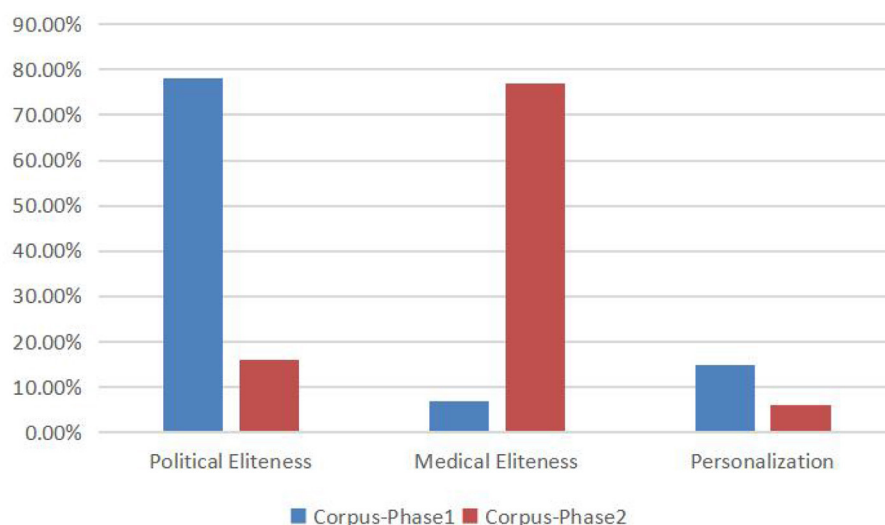
FIGURE 1
The construal of news values in the photographs in the Chinese media during two different COVID-19 phases (as percentages).

reactions, such as anaphylaxis, is about 2 cases per million. These conditions have been treated in a timely manner." Zeng Yixin (deputy head of the National Health Commission of China) said.

(*people.cn*, 2020-07-31)

Example 11

English translation: Jiang Rongmeng, member of the NHC expert team, said that recently, sporadic COVID19 cases occurred in many places of China, and the source of infection has not been thoroughly traced back, so there is still a risk of "transmission from objects to human beings."

(*people.cn*, 2020-07-29)

News values constructed by photographs

Each photograph from the two Chinese corpora and the news values it constructs have been analyzed from the perspectives of "content" and "camera technique" (25). In order to determine the news values that underpin each photograph, the results of the analysis were collated in an MS Excel spreadsheet as can be seen in Figure 1. It can be seen that the news photographs during two different phases construct utterly different news values.

Figure 1 shows that Eliteness is the commonly dominant news value constructed by Chinese media during the two phases. During the first phase, the portraits of Chinese political top leaders dominate the content of photographs, which are frequently taken as close-ups, with their faces and expressions clearly recognizable and with microphones and

platforms indicating powerful rights of speech (for example, the photograph portrays that President Xi Jinping delivered a speech at the conference on organizing COVID-19 prevention work, people.cn, 2020-02-24). Besides, a small part of Chinese political leaders are portrayed in the center of a group of people, in long shot photographs, flanked by subordinates and bodyguards (e.g., the photographs that portray President Xi Jinping visiting Beijing Ditan Hospital, with a group of officials standing behind him with blurred faces, *people.cn*, 2020-02-07).

Comparatively, during the second phase, Eliteness is mainly constructed through visual content by portraits of medical experts. Different from the portraits of political leaders during the first phase, the Chinese media did not depict the medical experts with individual close-ups, but with mid-shots of professional groups (e.g., the photograph captures two doctors in Wuhan provided remote diagnosis and treatment services for aged patients, *people.cn*, 2020-07-08; the group photograph depicts Huami Corporation cooperated with Zhong Nanshan and his medical research team to conduct post-hospital management of COVID-19 patients, *people.cn,* 2020-07-16). Besides, the medical Eliteness are mainly reinforced by professional equipment and academic background (for example, the remote diagnosis and treatment service facilities, *people.cn*, 2020-07-08; the prominent display of medical institutional logo and the academic seminar room, *people.cn*, 2020-07-16).

The news value of Personalisation has been constructed in a comparatively low frequency, through the portrait of the citizens in daily life or doctors and nurses in working (for example, the photograph portrays a cleaner carrying the disinfection work in the subway station, *people.cn,* 2020-01-23). Generally

speaking, the news values constructed by news photographs are in accordance with those construed by keywords and quotations, which are dominated by Eliteness of political top leaders during the first phase and by Eliteness of medical experts during the second phase.

Discussion

This discursive analysis of news values shows how a variety of words and images in Chinese media work together to construct a combination of news values. During the first phase when there was insufficient medical cognition on the virus, the Chinese media employed multimodal resources (both textual and visual) to forge a "political authoritative context model (46)", which portrayed a people-oriented government, a transparent notification mechanism and an immediate/scientific response capability to crises, and gave the public psychological support and cultivating positive attitude toward the government's policy. During the second phase when the cognition of COVID-19 virus had been greatly improved and more medical treatment and prevention methods had been developed, the "political authoritative context model" was replaced by the "medical specialized context model (46)" which was more vital to people's safety during the COVID-19 pandemic and could more directly give people a sense of security.

It is worth noting that the reason why the Political Eliteness can give the public psychological support and stabilize the society is because the Chinese government did respond efficiently and made effective policies to keep the novel coronavirus largely at bay and save lives. In its fight against the pandemic, China puts people first and follows a people-centered development philosophy to minimize the impact of the pandemic on economic and social development. In the more than 2 years since the COVID-19 pandemic erupted, the Chinese government has developed and implemented a dynamic clearing policy for the whole country, including regular testing and contact tracing, centralized quarantine and the use of big data to prevent the spread of the virus between cities. This strategy suggests a strong policy mix of NPIs and immunization, and an emphasis on avoiding lockdowns. Importantly, it requires local governments to rely on an epidemiology-backed system to respond early to cluster outbreaks and stop the spread of the virus (47). Moreover, the Chinese government has exerted appropriate and competent efforts in order to share information with the public during the pandemic (48). Based on the survey of Hu et al. (49), information disclosure was a top priority for official responses to the COVID-19 pandemic. The effective policing response made people feel they have received timely disclosure and gave them sufficient incentive to implement community prevention and control measures (50–52). Therefore, China's effective

governance is the reason for Chinese media to construct Political Eliteness in its news reporting as the dominant news value.

Scholars (53, 54) have demonstrated that public opinion support moderates various negative social factors including job stress, family crisis and people's job turnover intention. Media's reporting, as the most effective guide of the public opinion, exerted the greatest influence on the social stability. The strategic information broadcast of the media is indispensable in dispelling uncertainty, fear, and mental stress to unify global communities in collective combat against COVID-19 disease (55). It can be seen that during the two different pandemic phases, the Chinese media exercises overall control in the production of news discourse, making sure it is coherent in the narratives both textually and visually, and appropriate for constructing public confidence (56).

At the same time, the role of journalists in interpreting news events should be duly noted (39). Indeed, the values underpinning news are not intrinsic to any event, but assigned extrinsically by journalists (19). As Shirk (57), Sun (58) and Chan (59) claimed, China's news institutions are geared toward public service-oriented functions in modern times. In more pointed terms, the journalists working under the auspices of the government have the responsibility to select news stories that meet public expectation, for example, reporting the contents that the people are concerned about, using language with high public acceptance, guiding the public opinion positively, etc. (59). This DNVA study reveals the Chinese media's intentions and ways to establish a positive social context by constructing political and medical Eliteness in presenting a public health story to audiences (19).

Conclusion

This study is the first attempt to analyze news values in the COVID-19 news discourse, which has brought together corpus linguistic techniques, multimodal discourse analysis and DNVA to examine the ways in which new values are constructed through complex news resources. As noted above, this DNVA study has demonstrated that in facing an unprecedented health crisis such as the COVID-19 pandemic, with the absence of any treatment protocol or understanding of the medical ramifications, political authoritativeness is the first choice by Chinese media to construct public confidence. As Guan (60) pointed out, China is a society advocating the faith in politics, in which people have been educated to believe in the political philosophy (e.g., Marxism) and the political governance. Thus, it can easily be understood that when the health crisis is beyond people's capacity, politics features predominantly in the reporting/media as the spiritual or even supernatural backup.

This study has updated and improved the specifications of news values illustrated by previous DNVA studies. We have

found that the same news value can be constructed in different presentations. The dominant news value of Eliteness has been established as Political Eliteness by the media during the first pandemic phase, and established as Medical Eliteness during the second pandemic phase. While most of the previous DNVA studies interpreted the news values in one-fold presentation [e.g., (9, 15–18)].

This study has demonstrated the advantages of DNVA in analyzing media's mental model and behavioral model in the reporting of major health crisis crises. With the capabilities for multimodal discourse analysis, corpus-assisted discourse analysis, and ideological and power relational analysis, this DNVA framework has revealed the systematic process of newsworthiness construction, much more elaborately and clearly than many of the previous analyses of news discourse. Furthermore, news discourse analysis should continue to tell us truths about the values of a society. The news values and their construction ways presented in this essay provide a more in-depth framework to examine the social trend of thoughts during the COVID-19 pandemic. We hope this article has proved the application potentials of DNVA framework in public health crisis and introduced a new approach to social ideological analysis.

This study offers a new investigation of DNVA in COVID-19 news discourse and provides momentum to scholars worldwide who are interested in adopting DNVA to the topic of public health. With its focus on news values in Chinese stories, the paper also contributes to research on Asian context-centered analysis.

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

CC took charge of the data analysis and paper writing. RL took charge of the data collection and paper revision. All authors contributed to the article and approved the submitted version.

Conflict of interest

Publisher's note

References

1. Azadi NA, Ziapour A, Lebni JY, Irandoost SF, Chaboksavar F. The effect of education based on health belief model on promoting preventive behaviors of hypertensive disease in staff of the Iran University of Medical Sciences. *Arch Public Health.* (2021) 79:1–8. doi: 10.1186/s13690-021-00594-4

2. Maqsood A, Rehman G, Mubeen R. The paradigm shift for educational system continuance in the advent of COVID-19 pandemic: mental health challenges and reflections. *Curr Opin Behav Sci.* (2021) 2:1–5. doi: 10.1016/j.crbeha.2020.100011

3. Abbas J. The impact of Coronavirus (SARS-CoV2) epidemic on individuals mental health: the protective measures of Pakistan in managing and sustaining transmissible disease. *Psychiatr Danub.* (2020) 32:472–7. doi: 10.24869/psyd.2020.472

4. Su Z, McDonnell D, Wen J, Kozak M, Segalo S, Li X, et al. Mental health consequences of COVID-19 media coverage: the need for effective crisis communication practices. *Global Health.* (2021) 17:1–8. doi: 10.1186/s12992-020-00654-4

5. China.org.cn. *A Speech Delivered by Xi Jinping in Guiding the COVID-19 Epidemic Prevention and Controlling Work in Beijing.* Available online at: http://www.china.com.cn/opinion/theory/2020-02/26/content_75747764.htm (accessed February 10, 2020).

6. Palmer J. News production, news values. In Briggs A and Cobley P, editors. *The Media: An Introduction.* Harlow: Longman (1998). P. 377-391.

7. Palmer J. *Spinning into Control: News Values and Source Strategies.* Leicester: Leicester University Press (2000).

8. Bell A. *The Language of News Media.* Oxford: Blackwell (1991).

9. Caple H, Huan C, Bednarek M. *Multimodal News Analysis Across Cultures.* Cambridge: Cambridge University Press (2020).

10. Conley D, Lamble S. *The Daily Miracle: An Introduction to Journalism.* Oxford University Press (2006).

11. Harrison J. News media. In Albertazzi D and Cobley P, editors. *The Media: An Introduction.* London: Longman (2010). P. 246–57.

12. Richardson JE. Analysing newspapers. *An Approach from Critical Discourse Analysis.* Basingstoke: Palgrave Macmillan (2007).

13. Baker P, Gabrielatos C, McEnery T. *Discourse Analysis and Media Attitudes: The Representation of Islam in the British Press.* Cambridge: Cambridge University Press (2013).

14. Bell A. Language and the media. *Annu Rev Appl Linguist.* (1995) 15:23-41. doi: 10.1017/S0267190500002592

15. Bednarek M, Caple H. *News Discourse.* London/New York, NY: Continuum (2012).

16. Bednarek M, Caple H. *News Values-A Discursive Approach.* Available online at: http://qadda.com/NewsValues.html (accessed November 24, 2013).

17. Bednarek M, Caple H. Why do news values matter? Towards a new methodological framework for analyzing news discourse in critical discourse analysis and beyond. *Discourse Soc.* (2014) 25:135–58. doi: 10.1177/0957926513516041

18. Caple H, Bednarek M. Rethinking news values: what a discursive approach can tell us about the construction of news discourse and news photography. *Journalism.* (2016) 17:435–55. doi: 10.1177/1464884914568078

19. Bednarek M, Caple H. "Value added": language, image and news values. *Discourse Context Media*. (2012) 1:103–13. doi: 10.1016/j.dcm.2012.05.006

20. Caple H, Bednarek M. Delving into the discourse: approaches to news values in journalism studies and beyond. Report, The University of Oxford Oxford: The Reuters Institute for the Study of Journalism (2013) 1–29.

21. Bednarek M. Voices and values in the news: news media talk, news values and attribution. *Discourse Context Media*. (2015) 11:27–37. doi: 10.1016/j.dcm.2015.11.004

22. Bednarek M, Caple H, Huan C. Computer-based analysis of news values: a case study on national day reporting. *Journal Stud*. (2021) 22:702–22. doi: 10.1080/1461670X.2020.1807393

23. Zhang L, Caple H. The newsworthiness of Li Na-A critical comparative analysis of Chinese and international news media. *Lang Commun*. (2021) 77:70–80. doi: 10.1016/j.langcom.2021.01.002

24. NeJhaddadgar N, Ziapour A, Zakkipour G, Abolfathi M, Shabani M. Effectiveness of telephone-based screening and triage during COVID-19 outbreak in the promoted primary healthcare system: a case study in Ardabil province. *Iran. Z Gesundh Wiss*. (2022) 30:1301–6. doi: 10.1007/s10389-020-01407-8

25. Su Z, McDonnell D, Cheshmehzangi A, Li X, Cai Y. The promise and perils of Unit 731 data to advance COVID-19 research. *BMJ Glob Health*. (2021) 6:e004772. doi: 10.1136/bmjgh-2020-004772

26. Rahmat TE, Raza S, Zahid H, Mohd Sobri F, Sidiki S. Nexus between integrating technology readiness 20 index and students' e-library services adoption amid the COVID-19 challenges: Implications based on the theory of planned behavior. *J Educ Health Promot*. (2022) 11:1–10. doi: 10.21203/rs.3.rs-770218/v1

27. Yoosefi Lebni J, Moradi F, Salahshoor MR, Chaboksavar F, Irandoost SF, Nezhaddadgar N, Ziapour A. How the COVID-19 pandemic effected economic, social, political, and cultural factors: a lesson from Iran. *Int J Soc Psychiatry*. (2021) 67:298–300. doi: 10.1177/0020764020939984

28. Gui LL. Media framing of fighting COVID-19 in China. *Sociol Health Illn*. (2021) 43:966–70. doi: 10.1111/1467-9566.13271

29. Liu N, Chen Z, Bao GX. Role of media coverage in mitigating COVID-19 transmission: evidence from China. *Technol Forecast Soc Change*. (2021) 163:120435. doi: 10.1016/j.techfore.2020.120435

30. Langbecker A, Castellanos MEP, Catalan-Matamoros D. When public health systems are news: a comparative analysis of the journalistic coverage in Brazil and Spain. *Cinema Saude Colet*. (2020) 25:4281–92. doi: 10.1590/1413-812320202511.22532018

31. Andersen EM, Gronning A, Hietaketo M, Johansson M. Direct reader address in health-related online news articles: imposing problems and projecting desires for action and change onto readers. *Journal Stud*. (2019) 20:2478–94. doi: 10.1080/1461670X.2019.1603080

32. Colak FU. COVID-19 as a metaphor: understanding COVID-19 through social media users. *Disaster Med Public Health Prep*. (2022). doi: 10.1017/dmp.2022.83. [Epub ahead of print].

33. Trishchuk O, Grytsenko O, Figol N, Faichuk T, Vasyl T. Internet media during the COVID-19 crisis. *Cuestiones Politicas*. (2020) 38:264–75. doi: 10.46398/cuestpol.382e.20

34. CNR News. *National Health Commission: China's Epidemic Prevention and Control has Entered the Fourth Stage*. Available online at: http://health.cnr.cn/sy/zx/20220507/t20220507_525818259.shtml (accessed May 7, 2022).

35. Abbas J, Aman J, Nurunnabi M, Bano S. The impact of social media on learning behavior for sustainable education: evidence of students from selected universities in Pakistan. *Sustainability*. (2019) 11:1–23. doi: 10.3390/su11061683

36. Li Z, Wang D, Duan K, Mubeen R. Social media efficacy in crisis management: effectiveness of non-pharmaceutical interventions to manage the COVID-19 challenges. *Front Psychiatry*. (2021) 12:1–16. doi: 10.3389/fpsyt.2021.626134

37. Aqeel M, Rehna T, Shuja KH. Comparison of students' mental wellbeing, anxiety, depression, and quality of life during COVID-19's full and partial (smart) lockdowns: a follow-up study at a 5-month interval. *Front Psychiatry*. (2022) 13:1–17. doi: 10.3389/fpsyt.2022.835585

38. Baker P. *Using Corpora in Discourse Analysis*. London: Continuum (2006).

39. van Dijk TA. *News as Discourse*. London: Routledge (1990).

40. Kress GR, van Leeuwen T. *Reading Images: The Grammar of Visual Design*. London: Routledge (2006).

41. Schmidt CA, Cromwell EA, Hill E, Donkers KM, Schipp MF, Johnson KB, et al. The prevalence of onchocerciasis in Africa and Yemen, 2000-2018: a geospatial analysis. *BMC Med*. (2022) 20:293. doi: 10.1186/s12916-022-02486-y

42. Bednarek M, Caple H. *The Discourse of News Values: How News Organisations Create Newsworthiness*. Oxford: Oxford University Press (2017).

43. He J. "Why attacking the Bureau of industry and commerce?": news value flow to news comments on Chinese social media. *Media Cult Soc*. (2021) 43:733–49. doi: 10.1177/0163443721994433

44. Bednarek M. *Evaluation in Media Discourse: Analysis of a Newspaper Corpus*. London/New York, NY: Continuum (2006).

45. Kuo S. Language as ideology: analyzing quotations in Taiwanese news discourse. *J Asian Pac Commun*. (2007) 2:281–301. doi: 10.1075/japc.17.2.08kuo

46. van Dijk TA. Socio-cognitive discourse studies. In Flowerdew J and Richardson JE, editors. *The Routledge Handbook of Critical Discourse Studies*. London: Routledge (2018).

47. Zhang J. *China's anti-pandemic policy justified*. China Daily. (2022). Available online at: http://www.chinadaily.com.cn/a/202205/30/WS62940249a310fd2b29e5fa0e.html

48. Yang T, Shen X, Yang Y, Gan Y, Feng J, Lei Z, et al. Timeliness of information disclosure during the low transmission period of COVID-19: resident-level observational study in China. *BMC Public Health*. (2022) 22:415. doi: 10.1186/s12889-022-12804-x

49. Hu DT, Lou XQ, Xu ZW, Meng NN, Xie QM, Zhang M, et al. More effective strategies are required to strengthen public awareness of COVID-19: evidence from google trends. *J Glob Health*. (2020). doi: 10.2139/ssrn.3550008

50. Alam E. Enhancing the policing response to COVID-19 with media engagement: the United Arab Emirates experience. *J Policy Pract*. (2022) 16:311–24. doi: 10.1093/police/paac012

51. Alam E, Al abdouli K, Khamis A H, Bhuiyan HU, Rahman KA. Public trust in COVID-19 prevention and responses between March and June 2020 in Bangladesh. *Risk Manag Healthc*. (2021) 14:4425–37. doi: 10.2147/RMHP.S327881

52. Alam E. Cognition and collective action for COVID-19 prevention and resonse in the United Arab Emirates. In Louise CK and Rohdes M-L, editors. *Global Risk Management: the Role of Collective Cognition in Response to COVID-19*. London: Routledge (2021). P. 312.

53. Wei YJ, Ye ZH, Cui M, Wei XK. COVID-19 prevention and control in China: grid governance. *J Pub Health*. (2021) 43:76–81. doi: 10.1093/pubmed/fdaa175

54. Geng J, Ul Haq S, Ye H, Shahbaz P, Abbas A, Cai Y. Survival in pandemic times: managing energy efficiency, food diversity, and sustainable practices of nutrient intake amid COVID-19 crisis. *Front Environ Sci*. (2022) 13:1–16. doi: 10.3389/fenvs.2022.945774

55. Abbas J, Wang D, Su Z, Ziapour A. The role of social media in the advent of COVID-19 pandemic: crisis management, mental health challenges and implications. *Risk Manag Healthc Policy*. (2021) 14:1917–32. doi: 10.2147/RMHP.S284313

56. Cheng L, Cheng W. Documentary evidence as hegemonic reconstruction. *Semiotica*. (2014) 200:165–84. doi: 10.1515/sem-2014-0009

57. Shirk SL. *Changing Media, Changing China*. Oxford: Oxford University Press (2011).

58. Sun W. Rescaling media in China: the formations of local, provincial, and regional media cultures. *Chin J Commun*. (2012) 5:10–5. doi: 10.1080/17544750.2011.647738

59. Chan JM. From networked commercialism to networked authoritarianism: the biggest challenge to journalism. *Journalism*. (2019) 20:64–8. doi: 10.1177/1464884918806741

60. Guan H. *The Belief System and Political Development in Contemporary China*. Beijing: Peking University Press (2020).

Hesitant and anti-vaccination groups: A qualitative study on their perceptions and attitudes regarding vaccinations and their reluctance to participate in academic research- an example during a measles outbreak among a group of Jewish parents in Israel

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Background: Vaccination is widespread in Western countries and, overall, there is a high vaccination rate. However, immunization is still an enduring challenge. In recent years, the number of parents who choose to delay or refuse vaccines has risen.

Objectives: (1) to identify the perceptions and attitudes of hesitant and anti-vaccination parents regarding vaccination in general, and vaccinating their children in particular and; (2) to describe the responses of potential participants to the request to participate in academic research regarding their perceptions and attitudes on the subject of vaccines.

Methods: The research employs the qualitative hermeneutic phenomenological method using two research tools: (1) in-depth interviews with 7 hesitant and 11 anti-vaccination Jewish parents in Israel; and (2) the researchers' field notes from this study process, which describe the responses of 32 potential participants to the request to participate in this academic research.

Results: The main findings indicate that while most of the interviewees admit to the efficacy of vaccines in preventing diseases, they oppose the way in which vaccines are promoted—based on providing partial information and disregarding parents' concerns and questions. Therefore, they demand transparency about the efficacy and safety of vaccines. The findings also point to a paradoxical finding. On the one hand, these groups claim that

health organizations do not understand their position, referring to them as "science-deniers", even though they are not. On the other hand, these parents choose to refrain from participating in scientific studies and voicing their opinions, thereby perpetuating the situation of being misunderstood.

Conclusion: Hesitant and anti-vaccination groups express mistrust in academic institutions and health organizations. Therefore, an effective dialogue that would include hesitant and anti-vaccination groups, the academy, and health organizations may contribute to a better understanding of the barriers that prevent these groups from getting vaccinated or vaccinating their children and promote public health.

Introduction

Vaccination has been one of the most effective medical interventions to reduce death and morbidity caused by infectious diseases (1–3). While access to immunization is an enduring challenge, acceptance of and agreement to be vaccinated also remains an issue of great importance, and is affected by the individual's feelings, attitudes, and beliefs about vaccination (4). In recent years, the number of parents and individuals choosing to delay or refuse vaccines has risen (2, 5–7). Although there is generally a high rate of vaccination coverage in most developed Western countries, there is a growing number of individuals who express doubts and concerns about vaccination, also among parents who choose to vaccinate their children (8). Hesitant individuals who have questions and concerns have been shown to have lower levels of vaccination uptake (9), which may substantially impact vaccination coverage and increase the risk of outbreaks (10). By being vaccinated individuals are getting protected from being infected themselves and they also cannot pass this infection on to other people. However, to achieve herd immunity, a large proportion of the population needs to be vaccinated. This proportion varies depending on the germ and how contagious it is. Suboptimal vaccination coverage prevents herd immunity from being reached and extends susceptibility to vaccine-preventable diseases (11). Therefore, the World Health Organization (WHO) recognizes vaccine hesitancy as one of the 10 threats to global health (12), and recommends scaling up advocacy efforts to improve understanding of the value of vaccines and to allay fears leading to vaccine hesitancy (13). There is a wide spectrum of attitudes toward vaccination, including those who are pro-vaccination and accept all vaccines; those who are hesitant and have many concerns, but may entirely or partially vaccinate; and those who refuse all vaccines (6).

Several explanatory models were developed to elucidate the determinants of vaccine hesitancy. For example, The World Health Organization's (WHO) Strategic Advisory Group of Experts (SAGE) developed the "3Cs" model, which is based on three primary components: confidence in vaccines, complacency (low perceived usefulness of vaccination), and convenience (perceived constraints to accessing health or vaccination services) (14, 15). Another model developed by SAGE is the "Vaccine Hesitancy Determinants Matrix", which categorizes the reasons for hesitancy into three categories: contextual, individual and group, and vaccine/vaccination-specific influences (1). In addition, a conceptual model, adapted from a schema summary of discussions held during a workshop on the cultural and religious roots of vaccine hesitancy in Canada, illustrates that vaccine hesitancy at an individual level is influenced by a range of factors such as knowledge or experience; and historical, political, and socio-cultural influences (16).

All the models assume that vaccine hesitancy is affected by trust in health care professionals, the health care system, science, and socio-political context. Trust can be defined as "a relationship that exists between individuals, as well as between individuals and a system, in which one part accepts a vulnerable position, assuming the competence of the other, in exchange for a reduction in decision complexity" (17), such as providing information on the advantages and disadvantages of decisions. Trust is not uniform across all vaccines and may vary for different vaccine components (e.g., multiple antigens, adjuvants), for new vs. "old" vaccines, and according to past or present vaccine-associated controversies. Trust also depends strongly on patients' relationship with the healthcare professionals involved in vaccination: patients often seek a professional compatible with their values and beliefs; their trust is a precondition for the delegation of immunization and other health care decisions (16, 18, 19). In addition, a consensus between governments, their scientific advisors, and the public is crucial to sustaining effective and consistent communication.

This consensus is built on mutual trust between scientists and policymakers, and between governments and their citizens (20). Studies have shown that clear and constant communication by public health officials and government spokespersons affects public trust and increases the likelihood of people complying with recommendations and protective behaviors like vaccination (21, 22). Furthermore, inconsistent communication may decrease the public's trust in the government's ability to manage a crisis effectively, and increase skepticism about public health recommendations (23, 24).

Most of the scientific literature has focused on vaccine hesitancy rather than anti-vaccination. In the context of hesitancy, most studies have developed campaigns that can predict and measure hesitancy or persuade hesitant groups. For the authorities, understanding the attitudes that underline vaccination refusal and hesitancy is essential for predicting vaccination behavior and developing vaccination-promoting campaigns. Some studies focus on measuring vaccine hesitancy or anti-vaccination (25). Others consider hesitant and anti-vaccination groups a threat to people's health and herd immunity, and recommend developing strategies for debunking the myths peddled by the anti-vaccination movement and even introducing legislation that promotes or mandates vaccination (26). Recent systematic reviews focus on understanding the psychological factors that motivate people to reject the science in vaccinations (27, 28), analyzing anti-vaccine messages in social media (29), and identifying existing narrative interventions aimed at countering anti-vaccination conspiracy theories (28). In addition, a recent systematic review indicates a disconnect between the current vaccine hesitancy and the broader health-related trust literature (17).

However, few studies have focused on the anti-vaccination group and have mainly tried to understand and explore the history of the development of the anti-vaccination movements. The history of anti-vaccination, identified by medical anthropologist Anna Kata, includes questioning the safety and efficacy of vaccines, promoting alternative cures, claiming that vaccination infringes on individuals' civil liberties and asserting that vaccines are immoral (30). Anti-vaccination advocates typically represent well-organized entities with explicit agendas, ranging from financial interests (selling alternative cures) to ideological or political commitments (opposing specific legislation). Larson and colleagues suggest that organizations also frequently shift their goalposts, claiming that vaccines cause any number of maladies while supporting opposing political platforms, and that these themes are widespread on social media (31).

According to the above, most literature to date has referred to the hesitant group in order to characterize them and examine effective strategies to promote vaccination. Still, at the same time, it appears that it has failed to understand them and engage in dialogue with them. Therefore, this study aims to expose not the point of view of organizations toward the hesitant and anti-vaccination groups, as most literature discusses, but to focus on hesitant and anti-vaccination parents and how they perceive the health system and its attempt to communicate with them. This is a pioneering study as, to the best of our knowledge, almost no research to date has been conducted from the point of view of the opposing and hesitant parents.

This study seeks to provide a deeper understanding of the attitudes and perceptions of hesitant and anti-vaccination parents from their point of view, and aims to (1) identify the perceptions and attitudes of hesitant and anti-vaccination parents regarding vaccination in general, and vaccinating their children in particular and; (2) describe the parents' responses to the request to participate in academic research about their perceptions and attitudes regarding vaccination.

Methods

Research design and procedure

The research was conducted in Israel during a measles outbreak. The overall vaccination coverage rate in Israel is high (32, 33). However, parental hesitancy regarding recommended childhood vaccines has become more prevalent in Israel as in other countries in recent years (32–35). A recent assessment shows that 7.5%-9% of parents do not adhere to the routine vaccination schedule (36, 37). Vaccination compliance in Israel was found to rely on personal risk-benefit perceptions (38). Vaccine hesitancy in Israel is associated with higher education, indicating that hesitancy is a result of informed decision-making, rather than ignorance (37, 39). Elran and colleagues found that parents' decision to vaccinate their children is most influenced by their degree of trust in information sources about vaccination, particularly the nurses at the Mother and Child Health Clinics (32).

This research is based on a qualitative, hermeneutic phenomenological methodology as developed by Martin Heidegger (40). Heidegger proposed that humans are actors in the world. He focuses on the relationship between an individual and his/her lifeworld (41). Therefore, to investigate any individual or group in an in-depth manner, the researcher must first gain access to their lifeworld. This enables the researcher to share this world with others and to further explore what it means—socially, politically, and historically—to be a part of this lifeworld (41–43). Hermeneutic phenomenology seeks "to understand the deeper layers of human experience that lay obscured beneath surface awareness and how the individual's lifeworld, or the world as he or she pre-reflectively experiences it, influences this experience" (42). Heidegger's approach was used in this study to reveal new insights into hesitant and anti-vaccination participants' experiences of the vaccination process in Israel, including social and political

aspects, and particularly regarding their experience of how health organizations and the community perceive them.

We conducted in-depth interviews with 18 hesitant and anti-vaccination parents in Israel during a measles outbreak. The qualitative approach enables the researcher to examine the perceptions and attitudes of the research populations from the perspective of the individuals themselves. In addition, the use of qualitative, in-depth interviews stems from the difficulty of reaching the target audience of hesitant and anti-vaccination groups, and the subsequent difficulty of understanding these groups' attitudes and perceptions (44).

The study was approved by the the Faculty of Social Welfare and Health Sciences Ethics Committee for research with human subjects at the University of Haifa (Approval no. 421/17).

Sampling and data collection

The interviews were conducted by phone during a measles outbreak in Israel from April 2019 until August 2020. Although the study was conducted partly during the COVID-19 pandemic, most of the interviews were conducted before the COVID-19 outbreak in Israel, and only two interviews were conducted during the COVID-19 outbreak in Israel. Therefore, the interviewees were not asked about the COVID-19 virus and its vaccine. However, the interview guide focused on routine vaccination in Israel in general and the participants' experiences of the vaccination process in Israel. The duration of each interview was approximately half an hour.

In the first stage, the researchers performed a purposeful criterion intensive sampling of hesitant and anti-vaccination Jewish parents of children under 12 years of age, who agreed to participate in the study. We chose parents with children under 12 years of age because the recommended routine vaccination schedule in Israel is intended for children up to 12 years of age. Only parents who met the inclusion criteria were included in the study. According to Patton, purposeful sampling is "a technique widely used in qualitative research for the identification and selection of information-rich cases for the most effective use of limited resources" (45–47). Relevant participants were selected to supply as much knowledge as possible. In addition, the sample aimed to provide the maximum variation in order to reflect a wide variety of hesitant and anti-vaccination parents with regard to the parents' place of residence in Israel, education, and the children's age (47).

We approached potential participants through parents' groups on WhatsApp and Facebook. The groups were classified by the researchers as anti-vaccination and hesitant groups due to their self-identification and content. The researchers posted a post about the research and its goals on these groups, and invited parents to participate. Parents who agreed to participate, after receiving an explanation about the study and its objectives, were asked to contact the researchers and schedule a telephone interview.

To enlarge our sample, we proceeded to perform snowball sampling. Parents who had already participated in the study were asked to assist in identifying other potential interviewees. The researchers approached 10 potential interviewees, who agreed to participate in the study.

The researchers initially approached a total of 32 parents to participate in the study in the two sampling stages. A total of 18 out of the original 32 agreed to participate in the entire interview and completed the whole study process (see Table 1). The other 14 parents refused to be interviewed, but agreed to explain why they did not want to participate in the study. The Results section presents the interview findings, and details the reasons for parents' general reluctance and, finally, refusal to complete the full interview.

The interviews were conducted in Hebrew (the participants' first language) and audio-recorded. Then, they were transcribed verbatim and analyzed. Moreover, the recruitment process for each of the 32 potential participants we approached was recorded in the field notes. This includes their responses to the request to participate in an academic study, why they refused to participate, and how many times the researchers contacted them. Potential participants who refused to participate in the study were asked about the reasons behind their reluctance to participate in an academic study. Only reluctant participants who gave their consent to use their answers were included in this study.

Research tools

This study is based on two research tools. In-depth interviews were conducted based on the following interview guide (see Table 2). The interview guide questions were developed based on the scientific literature about vaccine hesitancy and anti-vaccination and the researchers' previous studies on vaccine hesitancy (48, 49).

The second research tool was the researchers' field notes (50, 51). In view of the study's second objective, the field notes describe the recruitment process in detail, including the difficulties of reaching the study population, the responses of the potential interviewees for the request to participate in the study, how many times the researchers contacted the potential interviewees, how much time passed until the interview was conducted, and the reasons why reluctant interviewees refused to participate in the study.

Credibility and validity

The information was accessible to the researchers, and all steps in the research process were transparent, as were the analytic methods and the interpretations of the findings (52).

Since the interviews were conducted, and the data analyzed by a single researcher, the data results and interpretations

TABLE 1 Sociodemographic characteristics of the interviewees (*N* = 18).

Variables		Hesitant (*N* = 7)		Anti-vaccination (*N* = 11)		Total (*N* = 18)	
		Frequency	Percentage (%)	Frequency	Percentage (%)	Frequency	Percentage (%)
Gender	Male	1	14.3	3	27.3	4	22.2
	Female	6	85.7	8	72.7	14	77.8
Age (years)	30–35	4	57.1	3	27.3	7	38.8
	36–40	2	28.6	3	27.3	5	27.8
	41–45	1	14.3	2	18.1	3	16.7
	46–50	-	-	3	27.3	3	16.7
Ethnicity	Jewish	7	100.0	11	100.0	18	100.0
Marital status	Single parent	-	-	1	9.1	1	5.5
	Married	6	85.7	8	72.7	14	77.8
	Widow	-	-	1	9,1	1	5.5
	Parent in a relationship	1	14.3	1	9.1	1	5.5
Education	Primary school	-	-	1	9.1	1	5.5
	Secondary	-	-	1	9.1	1	13.1
	BA	4	57.1	5	45.4	9	50.0
	MA	3	42.9	3	27.3	6	33.3
	PhD	-	-	1	9.1	1	5.5
Occupation/ profession	Self-employed	-	-	2	18.2	2	11.1
	Health worker	3	42.9	2	18.2	5	27.8
	Education	1	14.2	1	9.1	2	11.1
	Engineering	-	-	2	18.2	2	11.1
	Unemployed	-	-	1	9.1	1	5.6
	Other	3	42.9	3	27.2	6	33.3
Total		7	38.9	11	61.1	18	100.0

were discussed between the two main researchers during peer debriefing sessions (53). When there was disagreement about results interpretation and coding, this was discussed until a consensus was reached. Elaborated and detailed transcripts and written field notes increased study *dependability* (44, 54).

Analysis

Data were analyzed using thematic analysis (55). The transcripts were read and re-read, noting down initial ideas separately by two of the researchers. Then, initial codes were generated systematically across the entire data. The next step was extracting potential themes by looking over the codes we have created and gathering all data relevant to each potential theme. Specifically, we focused on the participants' attitudes toward vaccination, dilemmas in vaccination decision-making, concerns regarding vaccination, and the linkage between intention and behavior. Lastly, sub-themes were integrated into primary and secondary themes. Explanations and inferences are presented in the Results section, accompanied by quotes from the interviewees' statements.

Moreover, the field notes were analyzed by the researchers using conventional content analysis (56). We focused on refusing to participate in an academic study, identifying their reasons for not participating, and their trust in academic research. The researchers read all the data several times while focusing on the data about reluctant participants. Then, an initial analysis was conducted to derive recurring codes that identify the reasons for refusing to participate in an academic study. Subsequently, the researchers approached the text by making notes of their initial analysis, followed by labels for codes. Codes were then organized into two main categories and presented in the Results section.

Results

The results are divided into two parts following the study's objectives: (1) According to the first study objective, seven themes arose from the analysis of the interviews regarding hesitant and anti-vaccination parents' perceptions and attitudes and how the health authorities and the community perceive them. (2) According to the study's second objective, two themes

TABLE 2 Interview guide questions.

Question topics	Questions
Warm-up questions	• Can you please tell me about your lifestyle, with a focus on health-related issues?.
	• How do you keep your children healthy?.
Emotions toward vaccines	• What comes to mind when you hear the word "vaccination" or "vaccines"?.
	• How do you feel when you hear the word "vaccine" (e.g., safe, concerned, etc.,)?.
Attitude toward vaccination	• What is your general attitude toward vaccinating your children (Do/Have you vaccinate/d your children with all the routine vaccines, hesitate/d to vaccinate regarding a specific vaccine, or do you not vaccinate at all)?.
	• Has your attitude toward vaccines changed over the years?.
	• Did your attitude change from the first child to the second?.
	• Follow-up question: What are the reasons for this?.
Knowledge about vaccines, measles and MMR or MMRV vaccine against measles	• What did you know about vaccines during the decision-making process?.
	• What was most important for you to know about vaccines?.
	• In your opinion, what is the aim of vaccines?.
	• How do you think vaccines work inside the body?.
	• How do vaccines prevent disease?.
	• What are the advantages or benefits of vaccines?.
	• What are the risks of giving vaccines in general, or certain vaccines in particular?.
	• What do you know about measles?.
	• Have you vaccinated your children with the MMR vaccine?.
	• What do you know about the vaccine against measles?.
Risk perception and self-efficacy regarding their children contracting the disease	• Do you feel that your children are at risk of contracting measles and, if so, how do you protect your children from contracting measles?.
	• Do you feel that you have the necessary tools needed to protect your children from becoming infected with measles?.
Information sources	• Do you spend a lot of time searching for information on health issues? On what subjects?.
	• Do you spend a lot of time looking for information on vaccines?.
	• Do you spend a lot of time looking for information on measles and the vaccine against it?.
	• What information would you like to know about vaccines?.
	• What information would you like to know about measles and the vaccine against it?.
	• Where do you usually search for information?.
	• Do you feel you have the necessary tools needed to help you locate the information you are looking for?.
Perceived trust in the Ministry of Health, other health system organizations, and public health officials	• What is your level of trust in the Israeli health system (medical institutions and health workers)? Please elaborate and explain why.
	• Do you regard the Ministry of Health as a reliable source of information?.
	• Has the Ministry of Health ever provided information that answers your questions or concerns on a particular subject? Please elaborate.
	• Do you think you receive reliable and comprehensive information from the Ministry of Health?.
	• If not, how would you suggest the Ministry of Health improve the quality of the information provided?.
	• What factors affect the public's trust in the health care system in Israel (medical institutions and health workers)?.
	• What was your impression of the Ministry of Health's response during the measles crisis?.
	• What would you have advised the Ministry of Health to do during the measles outbreak in Israel?.
	• What information would you have advised the Ministry of Health to share with the public?.
	• Have you been exposed to information about the measles outbreak in Israel originating from the Ministry of Health?.
	• What information did you receive from the Ministry of Health?.
	• Do you feel that the Ministry of Health gave you reliable information about the measles outbreak in Israel?.
Misinformation and uncertainty in the social media	• Are you active on social networks? On which platforms and groups?.
	• Are you exposed to discourse on health issues? In what subjects?.
	• Have you been exposed to a debate about vaccines or measles on social media?.
	• Were you exposed to misinformation or uncertainty regarding health issues in social media and how has this information affected your attitudes and perceptions?.

arose from the analysis of the responses of hesitant and anti-vaccination parents to participate in academic study requests.

The first study objective: Hesitant and anti-vaccination parents' attitudes regarding vaccination in general, and vaccinating their children in particular from their perspective

This part of the results consists of seven themes and focuses on hesitant and anti-vaccination parents' perspectives of how they perceive vaccines, what they think about the vaccination process, and the way the health authorities perceive them (see Table 3).

Not "against" vaccines and vaccination, per se

Contrary to the popular belief that anti-vaccination individuals deny the effectiveness of vaccines, this study shows the opposite. Many of the interviewees (5 hesitant and 5 anti-vaccination) believe in the efficacy of vaccines in preventing diseases and their vital historical role in eradicating diseases.

"The benefits of vaccines historically in eradicating diseases is clear to me." (Interviewee 5).

However, they oppose the way in which vaccination is promoted because they don't believe in the necessity of all the given vaccines recommended by the Ministry of Health:

"The primary goal was to eradicate serious diseases that existed in the world, for which there was no treatment or not enough knowledge about their treatment. I think the primary goal of vaccines is good...When people started developing vaccines, they had a specific purpose in mind – to help the public." (Interviewee 15).

Instead, participants noted that vaccines should be given on an "as needed" basis (for example: at the time and place of a disease outbreak, when there is a real and present risk of infection, etc.,).

"During an epidemic outbreak, it is advisable to vaccinate only those populations that are at risk. For example, during a measles outbreak, only the population living in an area where there is an active outbreak should be vaccinated." (Interviewee 17).

How health organizations communicate vaccine information to the public

The ways in which health organizations communicate vaccine information to the public emerged as one of the main themes in this study. The interviewees described a lack of transparent communication by the Israeli Ministry of Health to the public, and emphasized the use of fear appeals to motivate the public to get vaccinated. Therefore, this main theme consists of two sub-themes: (1) a lack of transparency and ineffective communication between health organizations and the public; and (2) the strategic use of fear appeals.

Lack of transparency and ineffective communication between health organizations and the public

Thirteen out of 18 parents (5 hesitant and 8 anti-vaccination parents) mentioned that the Israeli Ministry of Health does not provide complete and accurate information in general, and regarding vaccines, specifically. Therefore, they demand transparency and providing the public with complete and accessible information.

"Explain the instructions [regarding vaccination] precisely and the rationale behind these instructions, instead of just giving instructions… explain why these instructions are given, so that people can understand, and provide reliable information sources, so that whoever wants to know where to find the information and understand the rationale behind it, can do so…The Israeli Ministry of Health needs to be as transparent as possible." (Interviewee 7).

According to these participants, the Israeli Ministry of Health provides partial information in an attempt to influence the public's decision-making process and motivate them to get vaccinated and vaccinate their children. Moreover, the interviewees mentioned that the information provided by the Israeli Ministry of Health does not address their concerns or answer their questions, but instead ignores public inquiries and concerns.

"The parents are given minimal information, unless they ask or investigate, as if to say: "You don't need to know; don't be confused by the facts, you're just parents." Thus, the level of information varies greatly from nurse to nurse at publicly funded Family Care Centers." (Interviewee 1).

The interviewees also expressed difficulty finding the information they were looking for concerning health issues and vaccination, describing it as inaccessible and unavailable. Only interviewees with a high level of education expressed high self-efficacy in searching for information and finding answers to their questions.

"I have degrees; I know how to look for information. I am very good at searching for information. I have patience. I know that my English is at the mother tongue level. I know how to read scientific studies and glean insights. But not everyone is like that, so transparency should be much higher. And accessibility to the information should be much higher." (Interviewee 15).

TABLE 3 Themes and sub-themes.

Themes	Sub-themes
1. Not "against" vaccines and vaccination, per se	
2. How health organizations communicate vaccine information to the public	2.1. Lack of transparency and ineffective communication between health organizations and the public 2.2. The strategic use of fear appeals
3. Vaccination process management by health organizations	3.1. Vaccination coercion vs. autonomy 3.2. Authorities' health decisions are motivated by conflicts of interest
4. Generic vaccination process vs. personalized vaccination	4.1. A tailored vaccination schedule 4.2. Splitting up vaccines
5. Persecution of anti-vaccination parents and dividing the community	
6. Vaccines' effectiveness and safety	6.1. Carrying out studies to test the effectiveness and safety of vaccines 6.2. Ignoring vaccine-related damages and reports on adverse effects
7. Correcting misinformation and communicating uncertainty on social media	

Consequently, they demand complete transparency to all the information when it comes to the process of decision-making regarding their health.

> "… There's no need to hide anything. Even if an epidemic, disease, or problem breaks out, the public should be informed about everything …Everything should be shared with the public." (Interviewee 17).

The strategic use of fear appeals

Many of the interviewed parents (2 hesitant and 8 anti-vaccination) said that the primary strategy used by health authorities to promote vaccination is fear appeals. Participants stated that the purpose of this strategy is to generate "hysteria" among the public regarding the severity of the disease and the consequences of non-vaccination. They also described this strategy as ineffective.

> "The Ministry of Health's strategy of intimidation doesn't work. Even those who study marketing know that intimidation only works to a certain extent." (Interviewee 3).
> "I didn't like all the hysteria. I think the goal was probably to motivate more people to get the vaccine, and I think it worked. So, maybe according to the Ministry of Health, they succeeded." (Interviewee 18).

Vaccination process management by health organizations

Vaccination process management by health organizations emerged as a main theme in this study. This theme consists of two sub-themes: (1) vaccination coercion vs. autonomy; and (2) authorities' health decisions are motivated by conflicts of interest.

The interviewees described how the Israeli Ministry of Health manages the vaccination process, including the motives and interests behind the decision-making process regarding vaccination, and how the autonomy principle is violated by presenting vaccination as obligatory although it is actually voluntary.

Vaccination coercion vs. autonomy

Five parents (2 hesitant and 3 anti-vaccination) expressed concern with what they perceived as vaccination coercion. They claimed that even though vaccination in Israel is voluntary, it is presented as being mandatory. Consequently, vaccination obligation is slowly being reintroduced.

> "The growing concern is the issue of forcing people to vaccinate, and lobbyists who seek to make vaccination mandatory, which is a violation of the individual's rights and freedom. This is the real struggle." (Interviewee 8).

The interviewees also believe that the principle of autonomy should not be violated. In addition, they feel that the individual's decision regarding vaccination should be entirely their own; instead, the health authorities make the decision for everyone. Therefore, the interviewees suggest that the parents should make an informed decision regarding vaccination, based on complete and transparent information from the health authorities.

> "If someone gets vaccinated, I don't say anything…everyone makes the best and right choices for their children. Everyone has their own considerations. And if you do choose to vaccinate your children, then that's the best thing for your children." (Interviewee 11).

Authorities' health decisions are motivated by conflicts of interest

Most of the interviewees (5 hesitant and 10 anti-vaccination) believe that the authorities' decision-making process is motivated by a conflict of interests and not only public health interests.

"In general, I don't think the Ministry of Health wants to kill us. But I do think that sometimes there are other interests that aren't in the public's best interest." (Interviewee 10).

For example, they believe that the authorities' decision-making process regarding vaccination is motivated by political and economic interests. These interests represent the shared interests of pharmaceutical companies and governments.

"I believe the power of lobbyists and pharmaceutical companies is too great, and very suspicious…Doctors can't just come out and say things against vaccines… I watched YouTube videos about doctors from the United States, who talked about how their lives had been threatened because of the studies they'd published." (Interviewee 13).

Generic vaccination process vs. personalized vaccination

Generic vaccination vs. personalized vaccination consists of two sub-themes: (1) a tailored vaccination schedule; and (2) splitting up vaccines. The interviewees suggested that the routine vaccination schedule should be modified according to the individual's needs, or the population's needs. They also suggested a personalized vaccination schedule, which is tailored according to the individual's health status and needs. In addition, some interviewees stated that they would agree to give their children certain vaccines if they were not given together with other vaccines.

A tailored vaccination schedule

Seven out of 18 parents (5 hesitant and 2 anti-vaccination) suggested that the vaccination schedule should be changed and adapted according to two levels of needs: individual needs and population needs. At the individual needs level, they stated that a vaccination schedule should be determined according to the child's needs and health status. Not all children need to receive all the vaccines. Some also recommended consulting an expert about which vaccines should be received and when to vaccinate.

"In a conversation with a representative from the Ministry of Health, she correctly said that this was a "recommendation", and her aim was to achieve the highest average in Israel. Vaccines are not necessarily suitable for every child, just as any treatment is not suitable for every person." (Interviewee 1).

At the population level, they asked questions regarding the legitimacy and purpose of mass vaccination. Some suggested that the routine vaccination schedule should be updated and changed because it is not adapted to our current daily lives. They explained that some vaccines should only be used in developing countries or countries that still experience outbreaks of these diseases.

"…Polio, for example. I think that only populations in third-world countries who are less hygienic, less healthy, and at a higher risk of becoming infected should be vaccinated." (Interviewee 2).

Splitting up vaccines

Giving combination vaccines arose as a concern and a reason that prevents parents from vaccinating their children. Five out of 18 parents (2 hesitant and 3 anti-vaccination parents) claimed that they would agree to inoculate their children with certain vaccines, but not if they were part of combination vaccines.

"There are vaccines, for example, that are only given as combination vaccines. For example, I have no problem with the Tetanus vaccine. But this vaccine is given together with a Diphtheria vaccine and a Pertussis vaccine." (Interviewee 1).

Persecution of anti-vaccination parents and dividing the community

Persecution of anti-vaccination parents is a theme that was mentioned by 6 parents (3 hesitant and 3 anti-vaccination). They described the discourse around vaccination on social media platforms as violent and aggressive. They also claimed that some health organizations, experts, and pro-vaccination individuals incite intolerance against anti-vaccination and hesitant groups.

"The discourse between pro-vaccination and anti-vaccination individuals on social media is very violent. I felt like if I told someone on the street that I don't vaccinate my child, they might just kill me. That's what the media and social networks have led to. The hand is very light on the keyboard. Many doctors on the net incite against anti-vaccination groups, mainly in this matter of dealing with diseases. They say there is no such thing as vaccine-related side effects, that everything has been studied, and you have to trust the authorities." (Interviewee 10).

In addition, the interviewees described the consequences of the violent discourse around vaccination as causing religious and social intolerance to vulnerable populations, such as ultra-Orthodox populations or low socio-economic populations.

"They divided the community by inciting religious and social intolerance; for example, by starting up with the ultra-Orthodox population because they do not vaccinate. They also incite against low socioeconomic status groups, although anti-vaccination parents do not belong to this population. This incitement is just terrible." (Interviewee 1).

As a result of expressing an anti-vaccination attitude or questioning a vaccine's efficacy and safety, some of the interviewees have been personally attacked, harassed, or intimidated online.

> "No parent would put themselves under attack and harassment. I received comments like: "Do not breed," "Let the Welfare Services take your children…" (Interviewee 8).

Vaccines' effectiveness and safety

The interviewees focused on two sub-themes: (1) questioning the effectiveness and the safety of vaccines; and (2) ignoring vaccines' related injuries and reports of adverse effects.

Carrying out studies to test the effectiveness and safety of vaccines

Seven interviewees (1 hesitant and 6 anti-vaccination) claimed that there is a lack of studies proving and ensuring the efficacy and safety of vaccines. Therefore, they want more studies to be carried out in the future, such as prospective, long-term studies that compare vaccinated children and unvaccinated children.

> "There is an utter lack of studies comparing vaccinated people to unvaccinated people… No study to date has examined the effect of the Pertussis vaccine and Influenza vaccine on pregnant women. This is a serious information gap for me. In addition, there is no prospective study following what happens to pregnant women who got vaccinated." (Interviewee 10).

Ignoring vaccine-related injuries and reports on adverse effects

The issue of ignoring reports on vaccine-related injuries and side effects was raised by eight interviewees (1 hesitant and 7 anti-vaccination). Participants explained that the health authorities do not recognize the harm or injuries caused by vaccines. The interviewees also claimed that they know parents of vaccine-injured children whose lives changed after vaccinating their children.

> "I know there's a lot of evidence from parents that can demonstrate their child's health status before and after vaccination, and I think it requires a thorough investigation and proper documentation… It shouldn't be dismissed or explained away by some excuse, like saying that autism often appears within the child's first year." (Interviewee 2).

In addition, parents explained that there is currently no existing system in Israel that collects and processes reports or follow-ups regarding injuries and side effects caused by vaccines. As a result, knowledge about the extent of side effects in Israel and worldwide is inaccurate and unreliable. Therefore, the interviewees first demand recognition of vaccine-related injuries on the part of the authorities, and full transparency regarding the issue of side effects.

> "The side effects of vaccines are underreported, and I think this is an important issue. The public doesn't get the real statistics on the adverse effects of vaccines…there is no reporting system. Therefore, the public doesn't know the incidence and prevalence of vaccine-related injuries and side effects." (Interviewee 16).

Correcting misinformation and communicating uncertainty on social media

Facing misinformation and uncertainty is very common on social media. Ten interviewees (4 hesitant and 6 anti-vaccination) suggested that they face a great deal of misinformation and uncertainty on social media.

> "I don't trust the social networks…they aren't a reliable source of information for decision making. For me, the media and social networks are a secondary source. First, I get information from a reliable source, and then from the social networks. But I don't make decisions based only on these networks." (Interviewee 2).

Some of the parents perceive themselves as having low self-efficacy in identifying misinformation and finding accurate information. Others claim they can find accurate information, and know how and where to look for it. In addition, they described social media networks as unreliable sources of information. Moreover, they expressed difficulty in understanding and identifying uncertain and unclear information.

> "Misinformation and uncertainty prevent me from deciding on complicated issues like vaccination. For example, if I read some information about a sports workout and I don't know whether it's correct or not, I won't do that workout." (Interviewee 14).

The second study objective: Parents' responses to the request to participate in academic research about their perceptions and attitudes regarding vaccination

During the preliminary process of the current study, 32 parents expressed initial consent to be interviewed. The study process and its goals were explained to these parents and interviews were scheduled. However, only 18 of the 32 interviews

were conducted. The other 14 parents refused to participate in the study for several reasons. These reasons were recorded in detail in the field notes. Two main reasons for refusing to participate arose from analyzing the field notes.

Inappropriate time scheduled for the interview

Eight potential participants refused to be interviewed claiming that the scheduled time of the interview was inappropriate. At first, they postponed and rescheduled the interviews because of various constraints, such as an unexpected meeting, having to take care of their children, etc.

"Sorry, but… I have an unplanned meeting today. Can we postpone the interview till tomorrow?" (Potential participant 7).

The researchers contacted them again, more than once, until they eventually overtly refused to participate in the study.

Mistrust in academic institutions

The second reason for non–compliance of participating in the study was the hesitant and anti-vaccination parents' mistrust in academic research and its institutions. Academic institutions and researchers were perceived as untrustworthy by 7 out of 32 participants. They said they believe that academic institutions have hidden interests and agendas to comply with the pharma industry and health authorities.

"Corrupt people neglect our health. The vaccines are part of it, and the source of the funding is the pharmaceutical industry. Academia cooperates with the pharma industry. The fact of the matter is, that the pharma industry bought academia." (Potential interviewee 2).

In addition, they think that most of the studies aim to promote vaccination and motivate more people to get vaccinated, instead of identifying the reasons that prevent the hesitant and anti-vaccination groups from vaccinating their children.

"But it's important for me to make it clear that we are skeptical toward studies aimed at improving communication with the public because, ultimately, we see that the goal of all these studies is to analyze the behavior of anti-vaccination people, and understand how to deal with these groups, instead of how to improve public health." (Potential Interviewee 3).

Moreover, they suggest a lack of freedom to publish, and say that studies criticizing vaccines and vaccination cannot be published.

"I'm telling you, even if your study is excellent and really presents our attitudes, they won't allow you to publish it. Your study will not be published in any scientific journal." (Potential Interviewee 2).

Some also claimed that hesitant and anti-vaccination parents' statements were manipulated in the media in order to damage their images. Therefore, they do not cooperate and refuse to be interviewed.

"Many parents' statements were manipulated in media interviews in which a trending edit was made to present them negatively. I wish you success in your research. I agree with you that it's important to bring a variety of opinions to academia and public debate." (Potential interviewee 12).

Therefore, the potential participants asked the researchers questions regarding the aim of the study, its funding resources, and previous studies conducted by the researchers.

Discussion

Vaccine hesitancy is one of the challenges that health organizations deal with in the public health sector. Most of the studies and meta-analyses in the literature have focused on developing strategies and campaigns to promote vaccination among hesitant and anti-vaccination subgroups [57, 58]. On the other hand, there is a lack of studies that examined the perception and attitudes of parents from their perspective. Therefore, this study aims to identify the perceptions and attitudes of hesitant and anti-vaccination parents, the way they see themselves, how they perceive the health authorities, and the way they think the health authorities and the community perceive them during the measles outbreak in Israel.

The present study found that most of the interviewees, including anti-vaccination parents (who do not vaccinate their children), do not oppose vaccination, in general. In fact, they believe in the efficacy and importance of vaccines historically, and in the vital role of vaccines in eradicating many diseases. However, they oppose the vaccination process, including the way in which vaccines are promoted. From their perspective, both should be changed.

Therefore, the interviewees suggest a comprehensive, preventive, personalized medicine approach, based on tailoring a personalized vaccination schedule according to the child's health and background information. This approach is like a personalized medicine approach, which focuses on tailoring the best individually-suited treatment based on the person's unique clinical, genomic, and environmental information [59]. In the field of prevention, personalized medicine, the literature indicates an emerging field of personalized vaccines. Theoretically, the idea of personalized vaccines—vaccines created to suit the individual—is based on a complex integration

of the person's genetics, environmental and other factors, and the influence of his/her immune system's responses to vaccines (60). Personalized vaccinology is based on the concept of vaccinomics and adversomics. This approach explores the influence of genetic and non-genetic regulation on the variation of vaccine-induced immune responses at both the personal and population levels (61). Thus, the movement toward a personalized vaccines approach is likely to decrease adverse events rates and increase the public's confidence in vaccines (62). In addition, it is important to understand that hesitant and anti-vaccination parents are not anti-science per se. However, they are against the health authorities' lack of transparency regarding the efficacy and safety of vaccines. In addition, they critique the lack of public involvement in the decision-making process, such as personalized vaccinology and the separation of combination vaccines, which would make it possible to identify the unique side effects of each vaccine. In contrast to this finding, many studies consider anti-vaccination individuals as disseminators of misinformation and conspiracies, as well as science deniers (63).

One claim that arose in this study against the way vaccines are promoted is the lack of transparency regarding the issue of vaccine-related injuries and reports of adverse events. In this study, the interviewees claimed that health systems and organizations throughout the world ignore vaccine-related injuries. For example, there is no proactive system for reporting adverse events in Israel. In the United States, there is a Vaccine Adverse Event Reporting System (VAERS). This system is co-managed by the CDC and the FDA, which aim to monitor the safety of vaccines after they have been authorized or licensed for use by the FDA. However, this system has several limitations. VAERS is a passive reporting system, meaning that reports about adverse events are not automatically collected. In addition, a causal relationship cannot be established using information from VAERS reports alone. Moreover, the number of reports submitted to VAERS may increase in response to media attention and increased public awareness. Therefore, it is impossible to use VAERS data to calculate an adverse event incidence rate among the population (64, 65).

Another claim against the way in which vaccines are promoted which emerged from the interviews is the fact that vaccine-related injuries are not recognized by the health systems and authorities. Some governments (particularly those countries that mandate vaccination) have implemented no-fault vaccine injury compensation schemes, as a legal mechanism of resource for individuals experiencing adverse events following vaccination. Such schemes compensate a person or family who has experienced a serious injury or death caused by a vaccine, when no fault was found in the manufacturing or administration of the vaccine. The process of deciding whether compensation can be awarded requires systems to assess the causal link between the vaccine and the injury or death (66), yet currently no such systems are available.

In addition, in this study vaccine acceptance was found to be affected by distrust and lack of confidence in the safety and efficacy of vaccines and immunization, as well as in the healthcare system. Trust in the vaccine delivery system with all its components was found to be an important influencing factor in several explanatory models of vaccine hesitancy-related decision making. These models include the "3Cs" Model (17), "Vaccine Hesitancy Determinants Matrix" (2), and schema summary of a workshop on the cultural and religious roots of vaccine hesitancy in Canada (16). According to these models, trust in the system that delivers vaccines and the different types of information about vaccines mediate vaccination decisions (16, 18, 19). Therefore, health organizations should gain the trust of the parents in order to affect their decision regarding vaccination. In the empirical studies, trust was shown to have a positive effect on vaccination intention and uptake in most of the studies reviewed in a systematic review (17). Another study found that trust by laypeople in health systems and organizations depends on their performance. Low levels of confidence in the overall vaccination system and government management may lead to vaccine hesitancy and lower vaccination coverage (67, 68).

In other studies, transparent communication was found to reduce negative emotions and increase individuals' sense of respect toward the organization and the institution (69). In addition, the assumptions of this approach are based on the assumption that if health organizations provide complete and transparent information and address the emotional element, it will be more effective than when they deliver one-dimensional, partial responses that do not address the public's fears and concerns (70–73). Moreover, the SAGE found that poor communication can undermine acceptance and increase vaccine hesitancy and vaccine refusal (2). The literature on health communication emphasizes the importance of transparent information from health organizations in regard to addressing the public's worries and concerns (70, 74), in order to empower and increase the perceived self-efficacy of individuals and communities (75, 76). However, the findings of this study indicate that the health system and authorities do not provide the public with complete and transparent information. Instead, they provide partial information, ignore people's concerns, and do not answer their questions.

As a result, the parents, as emerges from this study, must search for information *via* other resources such as the news media and social networks. Therefore, it is important for health organizations to correct misinformation and practice full transparency, while addressing the emotional aspects of all the subgroups regarding vaccination (pro-vaccination, hesitant, and anti-vaccination).

In addition, this study largely clarifies why hesitant parents are perceived as being opposed to vaccines in principle, rather

than those who simply oppose how the authorities promote vaccines in the public sphere. One explanation for this, as the study findings indicate, is their reluctance to participate in academic research. They claim that academic institutions and researchers have hidden agendas that serve the pharma industry and health authorities. As a result, a closed communication-loop situation is created. Paradoxically, hesitant and anti-vaccination parents choose to remain silent instead of expressing their attitudes and making their voices heard. This is because of the way they perceive the "bias" of all research conducted by academia. This perception should be further explored in future research.

Study limitations

Although this is not a quantitative study using a representative sample of hesitant and anti-vaccination groups, the qualitative method enabled us to gain a deeper understanding of vaccine hesitancy and anti-vaccination phenomena, rather than a surface description of the attitudes of a large sample of the population.

It is important to note that this study was partly conducted during the COVID-19 pandemic. The development of this new vaccine has changed what falls under the umbrella of "vaccine-hesitancy". An increasing number of parents and individuals chose to delay or refuse vaccination against COVID-19 (77). For example, vaccination acceptance in Israel dropped as additional doses of the vaccine were added (78). The vaccine hesitancy phenomenon has taken on a new meaning in which individuals who received all the vaccines—but have hesitant attitudes regarding the COVID-19 vaccine or refused to get vaccinated—were considered by their governments to be hesitant and anti-vaccination. Therefore, further studies should be conducted to study the specific implications of COVID-19 vaccination.

Conclusion

Recommendations for academic institutions

We recommend that academic institutions try to find new ways to make the voices of these groups heard (such as hesitant and anti-vaccination groups). Hesitant and anti-vaccination parents must also find a way to express their attitudes and perceptions. This is of great importance because, contrary to the prevailing stereotype of these groups as "conspiracy and misinformation disseminators" and "science deniers", the current study found that they actually believe in science and in the vital role of vaccines in preventing diseases.

Recommendations for health organizations

Health organizations need to engage in dialogue with hesitant and anti-vaccination groups. This dialogue should be based on a true and sincere interest in listening and understanding them, rather than trying to persuade them to change their minds.

In addition, health organizations should exercise caution in using a fear appeal strategy, which may adversely affect the public and lead to a lack of trust and cooperation. Instead, health organizations are advised to present all of the information, and openly address the public's fears and concerns. This may serve to increase the public's trust in health organizations and strengthen their reliability in the eyes of the public.

Therefore, the mutual collaboration of hesitant and anti-vaccination groups, academia, and health organizations may contribute to a better understanding of the barriers that prevent hesitant and anti-vaccination groups from getting vaccinated or vaccinating their children, thereby promoting public health.

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 Faculty of Social Welfare and Health Sciences Ethics Committee for research with Human Subjects at the University of Haifa (Approval no. 421/17). The patients/participants provided their written informed consent to participate in this study.

Author contributions

Conflict of interest

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

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References

1. Delany I, Rappuoli R, De Gregorio E. Vaccines for the 21st century. *EMBO Mol Med.* (2014) 6:708–20. doi: 10.1002/emmm.201403876

2. MacDonald NE. Vaccine hesitancy: definition, scope and determinants. *Vaccine.* (2015) 33:4161–4. doi: 10.1016/j.vaccine.2015.04.036

3. The United Nations Children's Fund (UNICEF). Immunization. (2022). Available online at: https://data.unicef.org/topic/child-health/immunization/. (accessed July 18, 2022).

4. Larson HJ. The biggest pandemic risk? *Viral misinformation Nature.* (2018) 562:309. doi: 10.1038/d41586-018-07034-4

5. Joslyn MR, Sylvester SM. The determinants and consequences of accurate beliefs about childhood vaccinations. *Ame Pol Res.* (2019) 47:628–49. doi: 10.1177/1532673X17745342

6. Larson HJ, Jarrett C, Eckersberger E, Smith DM, Paterson P. Understanding vaccine hesitancy around vaccines and vaccination from a global perspective: a systematic review of published literature, 2007-2012. *Vaccine.* (2014) 32:2150–9. doi: 10.1016/j.vaccine.2014.01.081

7. Motta M, Callaghan T, Sylvester S. Knowing less but presuming more: Dunning-kruger effects and the endorsement of anti-vaccine policy attitudes. *Soc Sci Med.* (2018) 211:274–81. doi: 10.1016/j.socscimed.2018.06.032

8. Kennedy A, Lavail K, Nowak G, Basket M, Landry S. Confidence about vaccines in the United States: understanding parents' perceptions. *Health Aff (Millwood).* (2011) 30:1151–9. doi: 10.1377/hlthaff.2011.0396

9. Damnjanović K, Graeber J, Ilić S, Lam WY, Lep Ž, Morales S, et al. Parental decision-making on childhood vaccination. *Front Psychol.* (2018) 9:735. doi: 10.3389/fpsyg.2018.00735

10. Smith LE, Amlôt R, Weinman J, Yiend J, Rubin GJ, A. systematic review of factors affecting vaccine uptake in young children. *Vaccine.* (2017) 35:6059–69. doi: 10.1016/j.vaccine.2017.09.046

11. Bertoncello C, Ferro A, Fonzo M, Zanovello S, Napoletano G, Russo F, et al. Socioeconomic determinants in vaccine hesitancy and vaccine refusal in Italy. *Vaccines (Basel).* (2020) 8:276. doi: 10.3390/vaccines8020276

12. World Health Organization. *Ten Threats to Global Health in 2019.* (2019). Available online at: https://www.who.int/news-room/spotlight/ten-threats-to-global-health-in-2019 (accessed July 18, 2022).

13. World Health Organization. *World Health Assembly Addresses Antimicrobial Resistance, Immunization Gaps and Malnutrition.* (2015). Available online at: https://www.who.int/news/item/25-05-2015-world-health-assembly-addresses-antimicrobial-resistance-immunization-gaps-and-malnutrition. (accessed July 18, 2022).

14. Butler R, MacDonald NE. Diagnosing the determinants of vaccine hesitancy in specific subgroups: the guide to tailoring immunization programmes (Tip). *Vaccine.* (2015) 33:4176–9. doi: 10.1016/j.vaccine.2015.04.038

15. World Health Organization. Report of the sage working group on vaccine hesitancy (2014). Available online at: https://www.asset-scienceinsociety.eu/sites/default/files/sage_working_group_revised_report_vaccine_hesitancy.pdf. (accessed July 18, 2022).

16. Dubé E, Laberge C, Guay M, Bramadat P, Roy R, Bettinger J. Vaccine hesitancy: an overview. *Human Vacc Immunother.* (2013) 9:1763–73. doi: 10.4161/hv.24657

17. Larson HJ, Clarke RM, Jarrett C, Eckersberger E, Levine Z, Schulz WS, et al. Measuring trust in vaccination: a systematic review. *Human Vacc Immunother.* (2018) 14:1599–609. doi: 10.1080/21645515.2018.1459252

18. Peretti-Watel P, Ward JK, Vergelys C, Bocquier A, Raude J, Verger P. 'I think i made the right decision … i hope i'm not wrong'. Vaccine hesitancy, commitment and trust among parents of young children. *Soc Health Illness.* (2019) 41:1192–206. doi: 10.1111/1467-9566.12902

19. Verger P, Dubé E. Restoring confidence in vaccines in the COVID-19 Era. *Exp Rev Vacc.* (2020) 19:991–3. doi: 10.1080/14760584.2020.1825945

20. Nutbeam D. COVID-19: lessons in risk communication and public trust. *Public Health Res Pract.* (2020) 30:e3022006. doi: 10.17061/phrp3022006

21. Dupras C, Williams-Jones B. The expert and the lay public: reflections on influenza a (H1n1) and the risk society. *Am J Public Health.* (2012) 102:591–5. doi: 10.2105/AJPH.2011.300417

22. Quinn SC, Parmer J, Freimuth VS, Hilyard KM, Musa D, Kim KH. Exploring communication, trust in government, and vaccination intention later in the 2009 H1n1 pandemic: results of a national survey. *Biosecur Bioterror.* (2013) 11:96–106. doi: 10.1089/bsp.2012.0048

23. Smith RD. Responding to global infectious disease outbreaks: lessons from sars on the role of risk perception, communication and management. *Soc Sci Med.* (2006) 63:3113–23. doi: 10.1016/j.socscimed.2006.08.004

24. Vaughan E, Tinker T. Effective health risk communication about pandemic influenza for vulnerable populations. *Am J Public Health.* (2009) 99 (Suppl. 2):S324–32. doi: 10.2105/AJPH.2009.162537

25. Martin LR, Petrie KJ. Understanding the dimensions of anti-vaccination attitudes: the vaccination attitudes examination (Vax) scale. *Ann Behav Med.* (2017) 51:652–60. doi: 10.1007/s12160-017-9888-y

26. Hussain A, Ali S, Ahmed M, Hussain S. The anti-vaccination movement: a regression in modern medicine. *Cureus.* (2018) 10:e2919. doi: 10.7759/cureus.2919

27. Eritsyan KY, Antonova NA, Tsvetkova LA. Studying anti-vaccination behavior and attitudes: a systematic review of methods. *Psychol Russ.* (2017) 10:189–97. doi: 10.11621/pir.2017.0113

28. Lazić A, ŽeŽelj I. A systematic review of narrative interventions: lessons for countering anti-vaccination conspiracy theories and misinformation. *Public Underst Sci.* (2021) 30:644–70. doi: 10.1177/09636625211011881

29. Wawrzuta D, Jaworski M, Gotlib J, Panczyk M. Characteristics of antivaccine messages on social media: systematic review. *J Med Internet Res.* (2021) 23:e24564. doi: 10.2196/24564

30. Kata A. Anti-vaccine activists. Web 20, and the postmodern paradigm–an overview of tactics and tropes used online by the anti-vaccination movement. *Vaccine.* (2012) 30:3778–89. doi: 10.1016/j.vaccine.2011.11.112

31. Larson HJ, Broniatowski DA. Volatility of vaccine confidence. *Science.* (2021) 371:1289. doi: 10.1126/science.abi6488

32. Elran B, Yaari S, Glazer Y, Honovich M, Grotto I, Anis E. Parents' perceptions of childhood immunization in Israel: information and concerns. *Vaccine.* (2018) 36:8062–8. doi: 10.1016/j.vaccine.2018.10.078

33. Stein-Zamir C, Israeli A. Timeliness and completeness of routine childhood vaccinations in young children residing in a district with recurrent vaccine-preventable disease outbreaks, Jerusalem, Israel. *Euro Surveill.* (2019) 24:pii=1800004. doi: 10.2807/1560-7917.ES.2019.24.6.1800004

34. Ashkenazi S, Livni G, Klein A, Kremer N, Havlin A, Berkowitz O. The relationship between parental source of information and knowledge about measles / measles vaccine and vaccine hesitancy. *Vaccine.* (2020) 38:7292–8. doi: 10.1016/j.vaccine.2020.09.044

35. Keshet Y, Popper-Giveon A. "I took the trouble to make inquiries, so i refuse to accept your instructions": religious authority and vaccine hesitancy among ultra-orthodox Jewish mothers in Israel. *J Religion Health.* (2021) 60:1992–2006. doi: 10.1007/s10943-020-01122-4

36. Amit Aharon A, Nehama H, Rishpon S, Baron-Epel O. Parents with high levels of communicative and critical health literacy are less likely to vaccinate their children. *Patient Educ Couns.* (2017) 100:768–75. doi: 10.1016/j.pec.2016.11.016

37. Velan B. Vaccine hesitancy as self-determination: an Israeli perspective. *Isr J Health Policy Res.* (2016) 5:13. doi: 10.1186/s13584-016-0071-x

38. Dror AA, Eisenbach N, Taiber S, Morozov NG, Mizrachi M, Zigron A, et al. Vaccine hesitancy: the next challenge in the fight against COVID-19. *Eur J Epidemiol.* (2020) 35:775–9. doi: 10.1007/s10654-020-00671-y

39. Gofen A, Blomqvist P, Needham CE, Warren K, Winblad U. Negotiated compliance at the street level: personalizing immunization in England, Israel and Sweden. *Public Administ.* (2019) 97:195–209. doi: 10.1111/padm.12557

40. Heidegger M. *Being and Time.* 7 ed New York: Harper. (1962).

41. Kafle NP. Hermeneutic phenomenological research method simplified. *Bodhi: An Interdiscipl J.* (2013) 5:181–200. doi: 10.3126/bodhi.v5i1.8053

42. Bynum W, Varpio L. When i say … hermeneutic phenomenology. *Med Educ.* (2018) 52:252–3. doi: 10.1111/medu.13414

43. Neubauer BE, Witkop CT, Varpio L. How phenomenology can help us learn from the experiences of others. *Perspect Med Educ.* (2019) 8:90–7. doi: 10.1007/s40037-019-0509-2

44. Montgomery P, Bailey PH. Field notes and theoretical memos in grounded theory. *West J Nurs Res.* (2007) 29:65–79. doi: 10.1177/0193945906292557

45. Creswell JW, Plano Clark VL. *Designing and Conducting Mixed Methods Research.* Third Edition ed Thousand Oaks, CA: SAGE. (2017).

46. Palinkas LA, Horwitz SM, Green CA, Wisdom JP, Duan N, Hoagwood K. Purposeful sampling for qualitative data collection and analysis in mixed method implementation research. *Admin Policy Mental Health.* (2015) 42:533–44. doi: 10.1007/s10488-013-0528-y

47. Patton MQ. *Qualitative Research & Evaluation Methods: Integrating Theory and Practice.* 4th Edition ed Thousand Oaks, CA: Sage. (2015).

48. Gesser-Edelsburg A, Diamant A, Hijazi R, Mesch GS. Correcting misinformation by health organizations during measles outbreaks: a controlled experiment. *PLoS ONE.* (2018) 13:e0209505. doi: 10.1371/journal.pone.0209505

49. Hijazi R, Gesser-Edelsburg A, Feder-Bubis P, Mesch GS. Pro-vaccination groups expressing hesitant attitudes: a cross-sectional study about the difference between attitudes and actual behavior in Israel. *Front Public Health.* (2022) 10:871015. doi: 10.3389/fpubh.2022.871015

50. Phillippi J, Lauderdale J, A. guide to field notes for qualitative research: context and conversation. *Qual Health Res.* (2018) 28:381–8. doi: 10.1177/1049732317697102

51. Tessier S. From field notes, to transcripts, to tape recordings: evolution or combination? *Int J Qual Methods.* (2012) 11:446–60. doi: 10.1177/160940691201100410

52. Riessman CK. *Narrative Analysis.* Newbury Park, CA: Sage. (1993).

53. Lombard M, Snyder-Duch J, Bracken CC. Content analysis in mass communication: assessment and reporting of intercoder reliability. *Human Commun Res.* (2006) 28:587–604. doi: 10.1111/j.1468-2958.2002.tb00826.x

54. Streefland P, Chowdhury AM, Ramos-Jimenez P. Patterns of vaccination acceptance. *Soc Sci Med.* (1999) 49:1705–16. doi: 10.1016/S0277-9536(99)00239-7

55. Braun V, Clarke V. Using thematic analysis in psychology. *Qual Res Psychol.* (2006) 3:77–101. doi: 10.1191/1478088706qp063oa

56. Hsieh HF, Shannon SE. Three approaches to qualitative content analysis. *Qual Health Res.* (2005) 15:1277–88. doi: 10.1177/1049732305276687

57. Dubé E, Gagnon D. MacDonald NE. Strategies intended to address vaccine hesitancy. *Rev Publish Rev Vacc.* (2015) 33:4191–203. doi: 10.1016/j.vaccine.2015.04.041

58. Olson O, Berry C, Kumar N. Addressing parental vaccine hesitancy towards childhood vaccines in the United States: a systematic literature review of communication interventions and strategies. *Vaccines (Basel).* (2020) 8:590. doi: 10.3390/vaccines8040590

59. Chan IS, Ginsburg GS. Personalized medicine: progress and promise. *Annu Rev Genomics Hum Genet.* (2011) 12:217–44. doi: 10.1146/annurev-genom-082410-101446

60. Poland GA, Ovsyannikova IG, Jacobson RM. Personalized vaccines: the emerging field of vaccinomics. *Expert Opinion Biolog Ther.* (2008) 8:1659–67. doi: 10.1517/14712598.8.11.1659

61. Poland GA, Ovsyannikova IG, Jacobson RM, Smith DI. Heterogeneity in vaccine immune response: the role of immunogenetics and the emerging field of vaccinomics. *Clin Pharmacol Ther.* (2007) 82:653–64. doi: 10.1038/sj.clpt.6100415

62. Poland GA, Ovsyannikova IG, Kennedy RB. Personalized vaccinology: a review. *Vaccine.* (2018) 36:5350–7. doi: 10.1016/j.vaccine.2017.07.062

63. Dubé È, Ward JK, Verger P, MacDonald NE. Vaccine hesitancy, acceptance, and anti-vaccination: trends and future prospects for public health. *Annu Rev Public Health.* (2021) 42:175–91. doi: 10.1146/annurev-publhealth-090419-102240

64. Centers for Disease Control and Prevention. Vaccine Adverse Event Reporting System (Vaers) (2021). Available online at: https://www.cdc.gov/vaccinesafety/ensuringsafety/monitoring/vaers/index.html (accessed July 20, 2022).

65. Chen RT, Rastogi SC, Mullen JR, Hayes SW, Cochi SL, Donlon JA, et al. The vaccine adverse event reporting system (Vaers). *Vaccine.* (1994) 12:542–50. doi: 10.1016/0264-410X(94)90315-8

66. Attwell K, Drislane S, Leask J. Mandatory vaccination and no fault vaccine injury compensation schemes: an identification of country-level policies. *Vaccine.* (2019) 37:2843–8. doi: 10.1016/j.vaccine.2019.03.065

67. Larson HJ, Cooper LZ, Eskola J, Katz SL, Ratzan S. Addressing the vaccine confidence gap. *Lancet.* (2011) 378:526–35. doi: 10.1016/S0140-6736(11)60678-8

68. Ozawa S, Stack ML. Public Trust and vaccine acceptance–international perspectives. *Human Vaccines Immunother.* (2013) 9:1774–8. doi: 10.4161/hv.24961

69. Lofstedt RE. How can we make food risk communication better: where are we and where are we going? *J Risk Res.* (2006) 9:869–90. doi: 10.1080/13669870601065585

70. Bennett P, Calman K, Curtis S, Smith D. *Risk Communication and Public Health.* 2 ed Oxford: Oxford University Press. (2010).

71. Lundgren REM AH. *Risk Communication: A Handbook for Communicating Environmental, Safety, and Health Risks.* Sixth Edition ed Piscataway, NJ: IEEE Press. (2018).

72. Sandman PM. Hazard Versus Outrage in the Public Perception of Risk. In: Covello VT, McCallum DB, Pavlove MT, editors. *Effective Risk Communication: The Role and Responsibility of Government and Nongovernment Organizations.* New York: Plenum Press (1989). p. 45–9.

73. Sandman PM. Crisis communication best practices: some quibbles and additions. *J Appl Commun Res.* (2006) 34:257–62. doi: 10.1080/00909880600771619

74. van der Bles AM, van der Linden S, Freeman ALJ, Spiegelhalter DJ. The effects of communicating uncertainty on public trust in facts and numbers. *Proc Natl Acad Sci U S A.* (2020) 117:7672–83. doi: 10.1073/pnas.1913678117

75. Gesser-Edelsburg A, Mordini E, James JJ, Greco D, Green MS. Risk communication recommendations and implementation during emerging infectious diseases: a case study of the 2009 H1n1 influenza pandemic. *Disast Med Public Health Prep.* (2014) 8:158–169. doi: 10.1017/dmp.2014.27

76. Vraga EK, Jacobsen KH. Strategies for effective health communication during the coronavirus pandemic and future emerging infectious disease events. *World Med Health Policy.* (2020) 12:233–41. doi: 10.1002/wmh3.359

77. Sallam M. Covid-19 vaccine hesitancy worldwide: a concise systematic review of vaccine acceptance rates. *Vaccines (Basel).* (2021) 9:160. doi: 10.3390/vaccines9020160

78. Israel Ministry of Health. *Covid-19 Data Tracker.* (2022). Available online at: https://datadashboard.health.gov.il/COVID-19/general (accessed July 20, 2022).

Relevance of the world health organization in a multipolar world in solving global health challenges

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There have been many criticisms about the World Health Organization (WHO) in the last decade. In a multipolar world, there are rivalries between nations and geopolitical regions. However, health issues remain outside the murky world of politics due to their far-reaching consequences on human society. The power conferred on the WHO is very significant in protecting the health and well-being of the global population. As a neutral organization, the WHO is supposed to uphold people's rights to health, especially in controlling diseases of international importance. The paper highlighted the significant roles of the WHO in leadership issues, research and development, solving disputes among countries, providing resources for low-performing regions, regulating international health laws, responding to a humanitarian crisis, and communicating during the crisis. Further, evidence from global literature critically analyzed the enforcement role of WHO on international health regulations (IHRs).

Introduction

With constant upheaval of world power centers, there are challenges in global health. At the dawn of the twenty-first century, the world seems to be in a multipolar state with a large political economy of nations. The world is not under one superpower, which would make it unipolar. With emerging economies like India, China, South Africa, Brazil, and many European countries, the world is multipolar now. Even African and South-East Asian countries are also emerging in economic power and diplomatic negotiations for health-related concerns. No more is the world lobbying around the United States of America (USA) and Russia, making a cold war of the past. The developments in the health sector follow global geopolitics, which ultimately decides global health diplomacy. Therefore, international global bodies must address health issues according to the need of space and time. As far as healthy human life is concerned, all the regions of the world are equally important. Other socio-economic and political issues should not infringe on healthcare governance globally.

Earlier, the WHO provided central leadership in the health sector for global health (1). The WHO has faced challenges at various stages in the scientific development and administration of healthcare (2). With a tradition of non-partition and an independent nature, the WHO should have high morals and sanctity. Usually, irrespective of providing funding and other tangible resources, no country puts pressure on the decision-making process of the WHO on health administration anywhere across the world (1). In other words, no one can put pressure to take undue advantage of the WHO's functions. In the past, the WHO had a commendable influence in war-torn territories, humanitarian crises, and epidemics (1). The work of the WHO has been notable in biomedical research and collaboration concerned with solving global medical crises. The WHO is well known for providing help with the global burden of disease on every continent.

Unlike many United Nations bodies, which acted partisanly and had terrible reputations, the WHO earned a fair amount of prestige (1). Despite not being generously funded, in the past the WHO was able to do its jobs with efficiency. Many countries found it great to work with WHO despite not being a member of the United Nations Organization (UNO). Many countries have membership in the WHO without participating in the larger geopolitical groups and the United Nations.

Any international organization not performing its desired role would be irrelevant in the crucible of time. There may be challenges in doing the job right, but it is necessary to remain relevant by accomplishing the job nonetheless. Criticism and overwhelming internal weakness make an organization inefficient. Hence, fresh notions and hard-hitting ideas are required in the WHO to make it more relevant in the coming decades (2). The world will face more challenges due to the movement of people, resources, and political thoughts in the coming days. Therefore, exemplary work by an international organization would help solve problems with proactive steps.

The world is like a household when it comes to many health emergencies. If one member suffers from ill health, others will be affected to some extent, whether physically, mentally, or spiritually. Restoring harmony with minimal damage without loss of time is a challenge. Without functional organizations in the health sector, there may be severe challenges in the global community. Hence, stewardship is required to restore the situation. Similarly, the macro parameters of health care achievement and management of health crises are the job of WHO (3). The regulations of WHO empower to enact sooner to quell the health crisis. Further, WHO and its multiple arms in research and development, program implementation, and resource mobilization must be effective. There is no excuse to avoid the crisis and keep blaming others. It is high time for the WHO to progress in multiple ways.

At the same time, beneficiaries, nation-states, multilateral agencies, and humanitarian groups must be active in helping out in the crisis to restore health. Overall, the restoration of health in human society is not just limited to the direct beneficiaries but also the whole ecosystem. The systems approach with emerging concepts like "one health" needs immediate attention without losing time. The scientific community is already upbeat with evidence from concepts like "one health" in society. This evidence must be translated into policies with progress in the health of the nations.

Authors argue that despite the global health crisis, the WHO faces daunting challenges in violating International Health Regulations and payed a minimal role in response to COVID-19 concerns (4). Recommendations converge toward cooperation and mutual strategic trust for overall progress in the health sector. Under the umbrella of the WHO, there is a requirement to work toward common interest, convergent operations on development, and resource allocation to combat COVID-19. Further, the WHO has to accelerate the mission of health diplomacy to reduce inequality by simplifying access to diagnostics, therapeutics, and vaccines, considering them as a global public good (4).

The paper focused on themes like leadership in research and development, role in solving disputes among countries, provision of resources for low-performing regions, regulating international health laws, response to the humanitarian crisis, and communication at the time of crisis for understanding the details of functions of the WHO. All the thematic areas are discussed critically with available evidence from the literature. The paper consulted search sites like PubMed, Scopus, Web of Science, and JSTOR to unravel the issues of critical concerns of WHO.

Leadership in development and research

The WHO, since its inception, projected to take leadership in health and development in the world arena. Technical assistance on health is the job of the WHO, irrespective of the level of development of a country. So that there would be a free flow of information, improving public health and timely intervention in the world. Many epidemics need immediate intervention, such as Ebola and COVID-19 in recent times. However, the WHO also depends on various other countries for proper investigation, which delays the matter to a great extent. Overall, the lack of leadership in investigating diseases and outbreaks is detrimental to the health of a large population. International bodies also reiterate the leadership of the WHO in improving access to health for global citizens.

The Oslo Ministerial Declaration in 2007 affirmed that health diplomacy must be part of central foreign policy (5). The ministerial group observed that health security and access to health by the people of the world have far-reaching positive externalities for the development of the world. Hence, the body also suggests measures for access to medicine by making flexibile

the Trade-Related Aspects of the Intellectual Property Rights (TRIPS) agreement of the Doha round of Intellectual Property Rights. It has been found that in one geography, everything may not be available, which necessitates the cooperation of the world for the production and distribution of healthcare products. Health is a much-neglected concern in a world where life is precious. A country with a compromised health system cannot ensure stability and security (5).

Authors argue that the coronavirus takes advantage of a divided political structure and non-cooperation (6). The factors necessary besides a strong health structure are social justice in societies, unity at the national level, and global solidarity to fight out a pandemic of the most significant scale. These are things the WHO must focus on to create more value. The current world needs extraordinary coordination across regional and political groups, along with solid relationships among scientists, policymakers, and civil societies. There is a need to take advantage of Global Health Diplomacy (GHD), Vaccine Diplomacy (VD), and Scientific Diplomacy (SD) to usher in a new era of healthcare dynamics for economic development, global health security, just society, and equitable healthcare (6).

Role in solving disputes among countries

Many disputes originated from the life sciences industries of various countries. Moreover, pharmaceutical issues are also critical to tackling at various forums to solve the issues. The neoliberal policies of global institutions make things more challenging to access medicines in the global south. There is also a requirement for international arbiters to solve issues of public health importance. The WHO aims to solve international health and human services disputes at the international level. As the WHO has expertise in health, it is supposed to advise and recommend measures for the solving of worldwide disputes on health issues. However, due to political influence, there is a lack of proactive steps from the WHO to solve many issues. If one problem arises, the WHO has to send its team to assess the situation. Transboundary laws should be in place to solve the major issues at the global level with dedicated resources. The diplomatic role of the WHO must effectively solve the issues with utmost care. However, in recent decades, the WHO has failed to resolve significant health issues among countries.

Reports confirmed that the US President took steps to cut ties with all WHO activities due to partisan politics. This is evident from the alignment of the WHO with China on the issue of the origin of COVID-19. In contrast, the Chinese president reiterated that China did nothing wrong in its virus notification, which affected the world. Further, the Chinese president announced financial grants to the WHO of $2 billion over 2 years (7). The issues of COVID-19 remain unsolved, with many countries affected by this.

Taiwan was denied membership in the WHO due to inhibitory policy from China. The Chinese government protested against Taiwan's rights, denying the right to be a member. There are also issues in many places affected by diseases and internal health laws in Asia and Africa, which remain unsolved by the WHO regarding access to medicine, healthcare, and Intellectual Property Rights. The disputes between many groups and countries are detrimental to the health and well-being of people.

Scholars argue that the WHO has to create an environment such that there should not be verbal attacks by one country on the other; instead, there must be cooperation to overcome crises (4). A dire crisis in international cooperation would result in failing the patients in terms of receiving essential medications and deceiving front-line healthcare workers. Hence, opinions converge on creating a shared resource pool and allocation (4). The dispute resolution wing must come into action to usher in global cooperation worldwide.

Providing resources for low-performing regions

The WHO has a fair amount of resources to implement various plans and programs relating to the health of underdeveloped countries. A dedicated part of the resources used to contain pandemics in developing countries is also available. However, the resources often do not reach the target audience to develop health and overall well-being. The danger of an epidemic does not just threaten the local population but also affects neighboring countries, and even sometimes those far off. The low-income regions of the world face difficulty controlling communicable and lifestyle diseases. Resource-starved countries need a lot of funding and technical support to fight these diseases. The WHO providing financial and technical support is supposed to provide healthcare services. There was a time when low-income countries needed resources for fighting deadly diseases like HIV/AIDS, malaria, and tuberculosis without sufficient resources and technical knowledge. Further, they do not have laboratories and medicines to fight against these fatal diseases. In global solidarity, the WHO has to take the lead for crowdfunding and provide high-end laboratory support to control diseases and reduce the mortality rate among a large population of developing countries.

The WHO raises funds from member countries and philanthropic organizations to fund the much-needed programs. There is also a need to provide health systems-related economic resources to transform the programs. The WHO needs to improve governance for the participation of developing countries optimally. Hitherto, it has been seen that despite the provision of appropriate resources, controlling diseases was a distant dream in developing countries due to a lack of

governance and corruption issues. However, in recent decades WHO also has had a severe lack of financial resources.

Reports found that the WHO is facing a resource crunch. The primary source of funding was formerly the contribution by member countries according to the assessment of contribution by the World Health Assembly of WHO. In the 1970s, around 62% of the budget came from mandatory contributions from member states, which declined to 18% in recent times (4). Even the Director General of the WHO informed the board about the need for increasing contributions. The director believed some funds were allocated after one major global outbreak. However, everything was forgotten afterwards once the epidemic receded. This means nothing less than failing to plan, which leads to planning to fail. The effort of the WHO can only be strengthened by increasing the budget (8, 9).

The African region receives grants in a different form, which are often insufficient to handle a significant outbreak. Moreover, LMIC are deprived of resources to fight many communicable and non-communicable diseases, including significant pandemics; this needs a meticulous approach to bridge the gap.

Regulating international health laws

There are many international trade and commerce regulators for the smooth functioning of business across the globe. The regulators ensure good practices by consulting various stakeholders for the outcome. Many countries have bilateral and multilateral diplomatic engagements to facilitate business worldwide. The matters of health and development are featured in many treaties and businesses relationship in a highly globalized world. The WHO often devises laws and regulations on healthcare and public health. The WHO acts as an arbitrator in many ways for the progress of international regulation on healthcare. Further, the regulations are democratically aligned with international conferences and conventions, which are agreed upon by member states. The WHO enforces laws and regulations for the welfare of humanity. However, it has been seen that the enforcement of regulations has been hampered over the last decade (2). The factors like political pressure, failure of diplomacy, and corruption pave the way for complacency in the WHO.

The WHO has to be neutral in every way possible to help countries with health emergencies. A neutral body following established procedures and laws is necessary for the development of the world. Without health regulations, there may be a disaster due to epidemics and fatalities worldwide. There are also overlapping trade and commerce laws with health laws. In this case, deciding to improve the population's health is tricky. Many pressure groups and nation-states continuously act as obstacles in various ways to derail the law enforcement power of the WHO.

International health laws are essential for the well-being of humanity. The WHO must be strong enough to enforce these regulations per established policies. In a multipolar world, there are issues and challenges for the WHO. However, with its technical and diplomatic channels, the WHO needs to be impressive enough to bring the importance of international regulations (2).

The WHO succumbs to the pressure of various nations, which leads to securing well-being. It faces the daunting challenge of violations of International Health Regulations (IHR) by many countries. Even, the WHO has not used its authority to investigate epidemics independently to enforce IHR worldwide. However, the recent punitive action by the USA to drastically reduce funds for the WHO will not help solve the enforcement of IHR in the world (10). Evidence found that solidarity among members of the WHO would help enforce international laws. Hence, WHO must be empowered with enforcement plans based on evidence-based and scientifically geared protocols (10, 11).

The IHRs change over time depending on the need of the hour. These are primarily adopted to combat outbreaks at the global level on a large scale. The United Nations ratified a set of iconic IHRs after a decade of severe acute respiratory syndrome (SARS), which is expected to create international coordination during public health emergencies (11). By ratifying the IHRs, one country must notify the WHO about all the public health concerns to form a Public Health Emergency of International Concern (PHEIC) consortium. However, without enforcement agencies, the WHO is toothless if a member country fails to give notice for any reason (3). Whatever the situation regarding the non-compliance of IHRs, there is a severe threat to humanity. Though PHEIC has successfully deployed to control diseases like Polio, H1N1, Ebola, and Zika, in the case of COVID-19, the committee has not done much (11).

In the context of the COVID-19 pandemic, many things went wrong in the decision-making process of the WHO and action was slow (12). International committees found the inefficiency of WHO in declaring PHEIC by almost 5 months, which led to a hefty toll worldwide in terms of mortality and morbidity. The WHO also failed to ensure travel bans and enforcement of IHRs to contain COVID-19 worldwide. Further, the hazy communications of the WHO made the situation critical. There had previously been successful events from the efforts of the WHO to tackle Ebola in 2014, and everything was declared in time (13–15).

There is a requirement for technical assistance, particularly training and follow-up, to improve IHR worldwide (16–18). Understanding the politics of the border movement and following IHR is needed to improve global health. On many occasions the movement of people is an obstacle in following IHR (19). There is a need for substantial and sustained increases in investments by WHO and various countries to prepare for global health emergencies with effective IHR (20–22). There is a

need to share administrative powers by the WHO with various actors for effective decision-making and implementation of IHR rather than a top-down approach (23, 24).

Response to humanitarian crisis

Due to various causes, there have been humanitarian crises worldwide. So, many well-established intergovernmental, government, and non-government organizations take steps to establish order. Humanitarian crises can happen in any part of the world, and they need immediate interventions according to United Nations conventions and other agreements. The WHO is among various organizations supposed to jump to the fore as soon as possible on health issues. The WHO is well accepted in many countries with its humanitarian assistance as a neutral party. Collaborations with various other agencies may bring value to the healthcare system within the WHO. The technical assistance and health services provided by an agency like the WHO are among the most vital (3). Many countries and worldwide forums ignore the vast amount of collateral damage in a humanitarian crisis. However, swift operation by WHO can reduce the concern for the people. However, the WHO is found to be irrelevant in its work in tackling the humanitarian crisis.

Communicating global emergencies

Communication of health emergencies remains a global challenge in a time of complex public health issues. Therefore, the role of the WHO is very important in communicating messages worldwide (12). There is a requirement of utmost sensibility in communicating scientific facts for the more significant benefit of the nations. Any mistake by the authority may lead to chaos. Further, to contain outbreaks and epidemics, it is necessary to have functional and practical communication media. The current dispensation is not sufficient to control the situations of health emergencies. Instead, there is a requirement of the community and intergovernmental bodies for the effective communication and dissemination of messages. For example, without knowing the details of health emergencies, if it is communicated at the global level, there may be havoc regarding the economy, which is not acceptable by the countries. Instead of doing a good service through health communication, it may escalate the disaster in different forms. Hence, sensible declaration and management of health emergencies are necessary.

The WHO plays a role in assessing and communicating health emergencies on the global stage. There is a need to empower health communication worldwide so far as epidemics are concerned. However, the WHO does not fulfill the job to the fullest extent worldwide (12). Here the

countries of the global south face more challenges than the developed world.

Influence of geopolitics on the WHO

The WHO is an international body that has to take the concerns of the entire world on health and development (3). It has regional offices in all the important geographies to tackle health emergencies and global health security. Overall, there is a firm conviction in the WHO to counter the world politics of health with direct presence and involvement. Though the headquarters are still in Geneva, the WHO can reach any corner of the world without losing much time. However, in recent times, it has been affected by many geopolitical concerns relating to the health politics of the nations. Many powerful countries influence the body to a great extent in different forms. Geopolitical concerns usually affect the decision-making process of the WHO. Not just in deciding the provision of healthcare support but also in influencing the scientific decisions of the WHO. Over decades, science has remained borderless and cultureless, out of politics, but the WHO cannot maintain that neutral role in scientific decisions. There are many accusations against WHO for being partisan globally (2). A partisan nature not just affects the working of WHO but also adds less value to the process of multilateralism.

Global geopolitics is affecting the functioning of the WHO at different levels. This also hampers the resource generation of the WHO. Big philanthropists are losing faith in the WHO and criticizing the entire process the WHO's functioning. There are charges on WHO being run by some groups of countries (2). The recent developments during the COVID-19 pandemic are one of the concerns.

Due to the One China policy respected by many nation-states, Taiwan was kept outside the ambit of WHO activities. The WHO was founded on controlling communicable diseases with non-partisan principles. The WHO must be apolitical to pave the way for creating values worldwide. Chinese pressure holds Taiwan as a ghost island, which is neither part of a nation nor a nation in itself. However, during the pandemic, Taiwan's work was a model for the world to replicate for COVID-19 management (25–27). Authors found that the WHO failed to manage COVID-19 across the world in contrast to the success of Taiwan. The region's geopolitics do not help Taiwan to be included in the WHO despite its effort in meaningful value creation in global health diplomacy (28).

The WHO is not free from the politics of a specific group of nations and their diplomatic approaches. During the pandemic, major trade and cultural exchanges continued. Often, the WHO could not implement regulations due to concerns about the geopolitics of various nations. Overall, general geo-economics and politics significantly influence the functioning of the WHO.

Negotiating intellectual property for better access to medication

Intellectual property is granted to encourage creativity and innovation. The incentives from Intellectual property are supposed to create more value in the future. The discovery of drugs and vaccines has a positive impact on medical development. The world has suffered from various diseases for some time. Medications are also available to treat many diseases. However, the price of medication becomes so high that it becomes difficult for the ordinary person to access those treatments. Third-world countries face an uphill task of matching the budget of innovators and pharmaceutical companies worldwide. The WHO must bridge the gap by negotiating medication prices for vulnerable sections of society. Even during a pandemic, there is no license waiver for better access and treatment of the world community. The WHO should take the discussion in such a way that there should be easy access to and production of vaccines and medicines worldwide.

The negotiation by WHO must be for the equitable distribution of rare global healthcare resources, like medications and vaccines, during health emergencies. The waiver of patents has helped access to drugs in the past, which the WHO must adopt every time during a global health security crisis. The WHO can negotiate with stakeholders like industry, nations' pressure groups, and multilateral bodies for the efficient production and distribution of medicines.

The role of WHO is very limited in trade negotiations, making the entire world suffer from a shortage of vaccines in the recent past. Despite developing vaccines with public money, licensing vaccines in favor of private firms limits access to the global south. There should be a relaxation of vaccine licensing in which the WHO plays a significant role.

The role of WHO in solving vaccine issues during COVID-19 is not noteworthy. LMIC especially faced many challenges in receiving vaccines timely and equitably (29, 30). In the absence of the intervention of the WHO the wealthier countries took undue advantage of vaccine distribution (31, 32). Hence the role of the WHO in ushering goodwill for vaccine diplomacy is inevitable.

Conclusion

This article highlights the issues of leadership in research and development, its role in solving disputes among countries, provision of resources for low-performing regions, regulating international health laws, response to the humanitarian crisis, and communication at the time of crisis, which, by and large, comes under the ambit of the WHO at international level.

However, the WHO was found to be ineffective in many of the parameters. Various reports and evidence by researchers confirm the feeble nature of the WHO in engendering goodwill. In a multipolar world, the WHO needs to be non-partisan and focus on controlling outbreaks and promoting health and well-being. There is a need for sufficient financial provision and good governance in the leadership of WHO.

To be relevant in the next decade, the WHO must efficiently manage global health security and public health diplomacy to create more value. The objectives of WHO must be redefined to match the aspirations of global citizens, which is essential to make life better across countries. Further, the WHO must tackle the issues of geopolitics and geo-economics aspects to implement various health programs per the scientific requirement for health and well-being.

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

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

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Conflict of interest

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

References

1. Park K. *Park's Textbook of Preventive and Social Medicine*. Jabalpur: Banarsidas Bhanot (2019). p. 1–10.

2. Fidler DP. *The World Health Organization and Pandemic Politics: The good, the bad, and an ugly future for global health*. (2020). Available online at: https://www.thinkglobalhealth.org/article/world-health-organization-and-pandemic-politics (accessed May 22, 2022).

3. Maxmen A. Why did the world's pandemic warning system fail when COVID hit? *Nature Springer Science and Business Media LLC*. (2021) 589:499–500. doi: 10.1038/d41586-021-00162-4

4. Javed S, Chattu VK. Strengthening the COVID-19 pandemic response, global leadership, and international cooperation through global health diplomacy. *Health Promot Perspect*. (2020) 10:300. doi: 10.34172/hpp.2020.48

5. Ministers Of Foreign Affairs Of Brazil France Indonesia Norway Senegal South Africa And Thailand. Oslo Ministerial Declaration—global health: a pressing foreign policy issue of our time. *Lancet*. (2007) 369:1373–8. doi: 10.1016/S0140-6736(07)60498-X

6. AlKhaldi M, James N, Chattu VK, Ahmed S, Meghari H, Kaiser K, et al. Rethinking and strengthening the Global Health Diplomacy through triangulated nexus between policymakers, scientists and the community in light of COVID-19 global crisis. *Glob Health Res Policy*. (2021) 6:12. doi: 10.1186/s41256-021-00195-2

7. Associated Press News. *China delayed releasing coronavirus info, frustrating WHO*. Available online at: https://apnews.com/3c061794970661042b18d5aeaaed9fae (accessed May 22, 2022).

8. Mahbubani K. *The Great Convergence*. New York: Public Affairs (2020).

9. WHO Report of the Director-General, 146th Meeting of the Executive Board (2020). Available online at: https://www.who.int/dg/speeches/detail/report-of-the-director-general-146th-meeting-of-the-executive-board (accessed May 22, 2022).

10. Venkatapuram S. A WHO fit for the 21st century. ORF (2020). Available online at: https://www.orfonline.org/expert-speak/a-who-fit-for-the-21st-century-67926/ (accessed May 22, 2022).

11. Gostin LO, Habibi R, Meier BM. Has global health law risen to meet the COVID-19 challenge? Revisiting the international health regulations to prepare for future threats. *SSRN Electronic Journal Elsevier*. (2020) 48:376–81. doi: 10.2139/ssrn.3598165

12. The Economics Times (Mar 11, 2021). WHO's pandemic response: From criticism to Nobel? 2021. Available online at: https://economictimes.indiatimes.com/news/international/world-news/whos-pandemic-response-from-criticism-tonobel/articleshow/81443977.cms?utm_source$=$contentofinterest&utm_medium$=$text&utm_campaign$=$cppst (accessed May 22, 2022).

13. Maurice J. Expert panel slams WHO's poor showing against Ebola. *Lancet*. (2015) 386:e1. doi: 10.1016/S0140-6736(15)61253-3

14. World Health Organization. *Report of the Ebola Interim Assessment Panel*. (2015). Available online at: https://www.who.int/csr/resources/publications/ebola/report-by-panel.pdf?ua$=$1 (accessed May 22, 2022).

15. Mackey TK. The ebola outbreak: catalyzing a "shift" in global health governance? *BMC Infect Dis*. (2016) 16:699. doi: 10.1186/s12879-016-2016-y

16. Razavi A, Collins S, Wilson A. Comment on Carson et al. strengthening global health security–lessons learned from Public Health England's International Health Regulations strengthening project. *Globalization and Health*. (2022) 18:50. doi: 10.1186/s12992-022-00844-2

17. Sharma UC, Attwood K, Pokharel S. Quantitative analysis of international health regulations annual reports to identify global disparities in the preparedness for radiation emergencies. *BMJ Open*. (2022) 12:e052670. doi: 10.1136/bmjopen-2021-052670

18. Vennis IM, Boskovic M, Bleijs DA, Rutjes SA. Complementarity of International Instruments in the Field of Biosecurity. *Front Public Health*. (2022) 10:894389. doi: 10.3389/fpubh.2022.894389

19. Piper J, Gomis B, Lee K. "Guided by science and evidence"? the politics of border management in Canada's response to the COVID-19 pandemic. *Front Polit Sci*. 2022:17. doi: 10.3389/fpos.2022.834223

20. Clarke L, Patouillard E, Mirelman AJ, Ho ZJM, Edejer TT-T, Kandel N. The costs of improving health emergency preparedness: a systematic review and analysis of multi-country studies. *eClinicalMedicine*. (2022) 44:101269. doi: 10.1016/j.eclinm.2021.101269

21. Burci GL, Forman L, Hoffman SJ. Introduction to a special issue on reforming the international health regulations. *Int Organ Law Rev*. (2022) 19:1–10. doi: 10.1163/15723747-19010009

22. Velásquez G. The World Health Organization Reforms in the Time of COVID-19. *Vaccines, Medicines and COVID-19*. (2022). p. 93–108. doi: 10.1007/978-3-030-89125-1_6

23. Vese D. On the administrative powers of the WHO: a lesson from the pandemic. *Eur J Health Law*. (2022) 1:1–16. doi: 10.1163/15718093-bja10093

24. Forman L, Sekalala S, Meier BM. The world health organization, international health regulations and human rights law. *Int Organ Law Rev*. (2022) 19:37–62. doi: 10.1163/15723747-19010002

25. American Institute in Taiwan. U.S.-Taiwan joint statement (2020). Available online at: https://www.ait.org.tw/u-s-taiwan-joint-statement/ (accessed May 22, 2022).

26. Chang JLJ. Taiwan's participation in the world health organization: the US "facilitator" role. In: *The Future of United States, China, and Taiwan Relations*. New York: Palgrave Macmillan (2010). p. 167–87. doi: 10.1057/9780230118966_9

27. Chen PK. Universal participation without Taiwan? a study of Taiwan's participation in the global health governance sponsored by the World Health Organization. In: *Asia-Pacific Security Challenges*. Springer, Cham (2018). p. 263–81.

28. Yin JD-C. WHO, COVID-19, and Taiwan as the Ghost Island. *Global Public Health Informa UK Limited*. (2021) 16:1267–82. doi: 10.1080/17441692.2021.1890184

29. Gorodensky A, Kohler JC. State capture through indemnification demands? Effects on equity in the global distribution of COVID-19 vaccines. *J Pharm Policy Pract*. (2022) 15:50. doi: 10.1186/s40545-022-00442-y

30. de Bengy Puyvallée A, Storeng KT. COVAX, vaccine donations and the politics of global vaccine inequity. *Glob Health*. (2022) 18:26. doi: 10.1186/s12992-022-00801-z

31. Zhang D, Jamali AB. China's "weaponized" vaccine: intertwining between international and domestic politics. *East Asia*. (2022) 39:279–96. doi: 10.1007/s12140-021-09382-x

32. Peng Y. Politics of COVID-19 vaccine mandates: Left/right-wing authoritarianism, social dominance orientation, and libertarianism. *Pers Individ Dif*. (2022) 194:111661. doi: 10.1016/j.paid.2022.111661

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Association between physical activity and major adverse cardiovascular events in northwest China: A cross-sectional analysis from the Regional Ethnic Cohort Study

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Background: To examine the association between daily physical activity (PA) and major adverse cardiovascular events (MACEs) in northwest China.

Methods: The data in this analysis were part of the baseline survey of the Regional Ethnic Cohort Study in Northwest China from June 2018 to May 2019 in Shaanxi Province. This study used standardized self-reported total physical activity (continuous and categorical variables) and self-reported outcomes of MACEs. All analyses were conducted using the logistic regression model and stratified by age, sex, body mass index (BMI), and region. The dose-response relationships were assessed with a restricted cubic spline.

Results: The average level of total PA was 17.60 MET hours per day (MET-h/d). Every increase of four MET-h/d of total PA was associated with a lower risk of MACEs [adjusted OR = 0.95 (95% CI, 0.93~0.98)]. Compared with participants in the bottom quartile of total PA, a lower risk of MACEs was observed in the top quartile group [≥23.3 MET-h/d, 0.68 (0.55~0.83)]. Stratified analyses showed similar results in males, females, participants over 45 years old, participants in the rural region, and normal weight range participants (BMI < 24 kg/m^2). Total participants also observed a dose-response relationship after adjusting for socioeconomic and lifestyle factors.

Conclusions: A higher level of PA was associated with a lower MACE risk. Future research should examine the longitudinal association of prospectively measured PA and the risk of MACEs.

Introduction

Major adverse cardiovascular events (MACEs) have been used in cardiovascular disease (CVD) research, with MACEs selected as the primary or secondary endpoint (1). Physical activity (PA) is an easily modifiable lifestyle factor that is widely recommended due to its demonstrated beneficial effect on health outcomes (2, 3), both physically (4) and psychically (5–7). It is also an essential behavioral risk factor for CVD (8). A cohort study in China demonstrated that the population attributable risk of major coronary events due to lack of PA was 21.6% (9). In addition, a meta-analysis showed that a high level of leisure-time PA and a moderate level of occupational PA have beneficial effects on cardiovascular health (10).

The prevalence of a high risk of CVD illustrated a regional disparity in China, especially in the northern region (9.6% in the northwest region, 12.6% in the northeast region, and 8.0% in the south region) (11). Additionally, the disease patterns in China differ notably from those in high-income countries (e.g., there were higher rates of stroke than ischemic heart disease in China) (12, 13) and vary significantly between regions (e.g., stroke was more common in the eastern region, and myocardial infarction was more common in the central and western regions) (8). Most previous studies on the association between PA and the risk of MACEs were based on studies conducted in high-income countries (14–17), lacking evidence from China. A prospective cohort study in 10 areas across China found that every increase of four metabolic equivalents of task (MET) hours per day reduced the risk of major vascular events by 6% (18). A prospective study in the United States showed that each MET improvement in midlife was associated with a 17% lower risk of heart failure hospitalization in later life (19).

In addition, the patterns of PA, including the domains and intensity of physical activities, appear to vary greatly across different regions in China (20). A prior study showed that the prevalence of leisure-time PA in adults was also lower in undeveloped western areas than in central and eastern China (21). Therefore, studies focused on specific regions with distinctive characteristics, such as relatively poor financial terms, varied regional topography, and ethnic diversity (22), are warranted.

Based on data from the baseline surveys of a large prospective study in northwest China, this study aimed to quantify the relationship between PA and MACE risk in Shaanxi Province and assess whether the association differed by sex, age, body mass index (BMI), and region. Besides, considering that people with diabetes have specific features that lead them to higher CVD risk compared with the general population, we further test the association between total PA and the risk of MACE in the participants with and without diabetes as an exploratory analysis.

Materials and methods

Study design and study population

The analyses were based on data from the Regional Ethnic Cohort Study in Northwest China (RECS), a community population-based prospective observational study in which participants completed a baseline survey from June 2018 to May 2019. The study design, methods, and recruitment strategy have been described previously (22). All study procedures were conducted following the ethical standards of the responsible committee on social and behavioral science research and with the Helsinki Declaration of 1975, revised in 2000. This cohort study was approved by the Human Research Ethics Committee of Xi'an Jiaotong University (No: XJTU2016-411). All participants were informed and signed the informed written consent.

In this analysis, we focused on 48,025 participants from Shaanxi Province to explore the association between PA levels and the risk of MACEs. After data cleaning and logical verification, we excluded those participants who were pregnant ($n = 1,591$), had limited basic activities of daily living ($n = 4,736$), had illogical data (e.g., the sum of total PA hours and sleep hours exceeded 24 h per day; $n = 5,533$), were younger than 18 years old at the baseline survey ($n = 1$), and had missing exposure variables ($n = 1,567$), leaving 34,597 participants for this analysis (Figure 1).

Physical activity measurements

The questions on physical activity in this study were in line with the questionnaire of the China Kadoorie Biobank (CKB) (18). The questionnaires were adapted from validated questionnaires used in several other studies, including high-income countries (23) and the Chinese population (24), with some additional modifications after a CKB pilot study (25). However, the questionnaires have not been compared directly with a reference method, such as an accelerometer (18).

Metabolic equivalent tasks (METs) from the 2011 update (26) of a major compendium of physical activities were used to quantify the amount of PA (Supplementary Table 1). PA has been defined as "any bodily movement produced by skeletal muscles that result in energy expenditure" >1.5 metabolic equivalents (27), including time spent in light, moderate and vigorous intensity (26). The designed questionnaire used in the baseline survey of this cohort study covered relevant questions on the intensity, frequency, and time spent on occupational tasks, commuting, household tasks, and sports activities. The MET of each activity was subsequently multiplied by the frequency

FIGURE 1
Flow diagram of the study population.
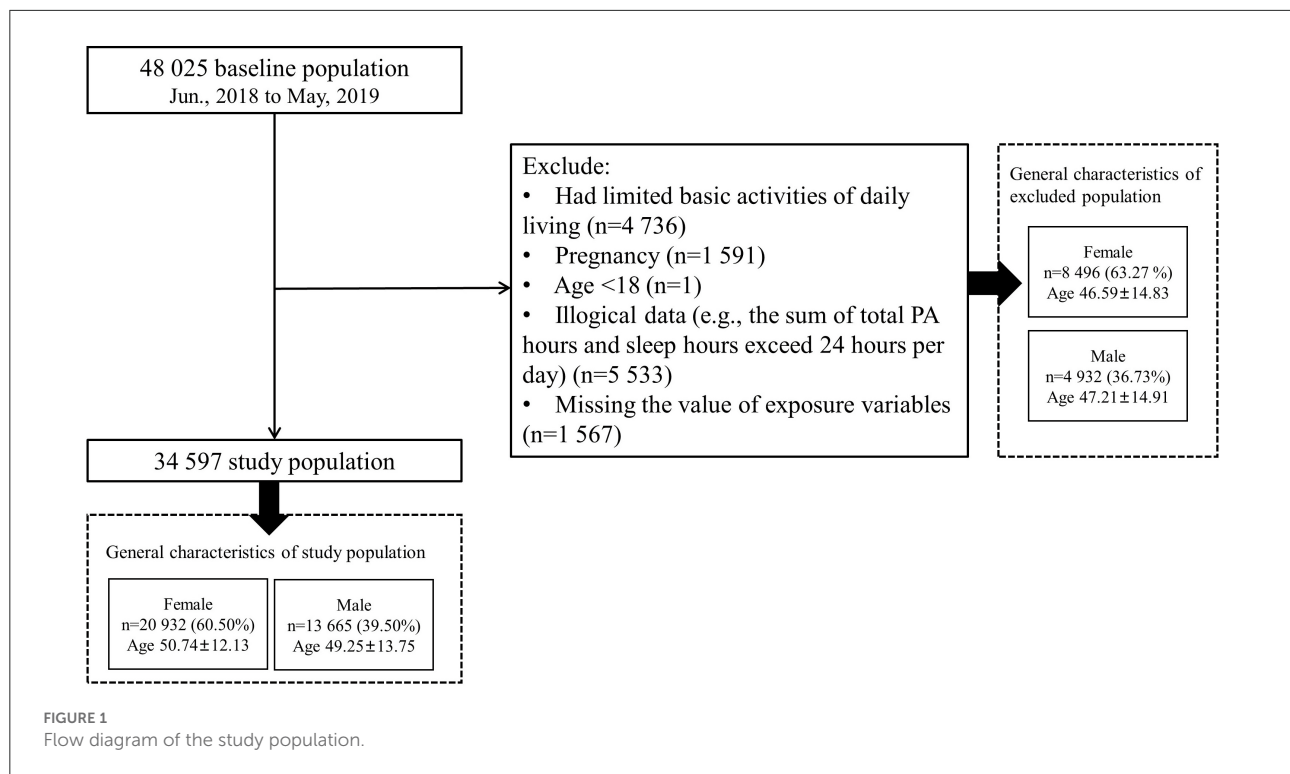
and duration of physical activity and summed together to calculate total physical activity in MET hours per day (MET-h/d).

Covariates

The participants completed a questionnaire and underwent a physical health examination, including measurements of height (cm) and weight [kg; from which body mass index (BMI) was calculated as kg/m^2]. Based on the recommended cutoff points for Chinese adults (28), we categorized BMI into three groups: normal weight (BMI < 24 kg/m^2), overweight (24 kg/m^2 ≤ BMI < 28 kg/m^2), and obesity (BMI ≥ 28 kg/m^2).

Based on the prior studies (18, 29) and knowledge, we considered sociodemographic factors and lifestyle factors as potential confounders. To facilitate choosing confounders for adjustment, we constructed a conceptual framework to visualize relationships among the exposure, outcome, and confounders by using directed acyclic graphs (DAGs; Supplementary Figure 1) with the DAGitty program (http://dagitty.net/, version 3.0) (30). The final set of confounders that we chose to adjust contained age (continuous, years), sex (male and female), study location (categorized as six different regions), household annual income [<10,000, 10,000–50,000, 50,000–100,000, and ≥100,000 RMB (yuan)], and education (no formal school, primary school, middle school, and college

and above). Lifestyle factors included smoking (current smoker and nonsmoker), alcohol consumption (current drinker and nondrinker), sedentary leisure time (continuous, hours per day), fruit intake (every day, 4–6 times per week, 1–3 times per week, 1–3 times per month, and never intake fresh fruit), and self-reported general health status (excellent, good, fair, and poor).

Outcomes

The primary outcome of this analysis was the prevalence of MACE. Given that this analysis was based on cross-sectional data, MACE was defined as stroke and nonfatal acute myocardial infarction (AMI) (1, 31). The outcomes were obtained from the following self-reported questions:

"Are you suffering from chronic diseases? (yes/no)."

(1) *"Have you ever had an acute myocardial infarction? (yes/no)."*
(2) *"Do you have a stroke/minor stroke? (yes/no)."*

We defined participants with AMI and/or stroke/minor stroke as the participants with MACE. Participants who missed both data were treated as missing data. The rest of the population was treated as non-MACE participants. AMI and stroke/minor stroke were set as secondary outcomes to explore the association between PA and CVD.

TABLE 1 Characteristics of Shaanxi Province people by levels of physical activity[a].

Characteristics	Total physical activity (MET-h/d)[b]					p-value
	Total	<9.0	9.0–15.2	15.3–23.2	≥23.3	
No. of participants	34,597	8,628	8,670	8,644	8,655	
Mean ± SD						
Age, years	50.15 ± 12.81	55.97 ± 11.20	49.76 ± 13.33	45.79 ± 12.85	49.10 ± 11.60	<0.001
BMI, kg/m^2	23.80 ± 3.40	23.80 ± 3.42	23.78 ± 3.39	23.81 ± 3.41	23.83 ± 3.40	0.801
Physical activity–related factors						
Total physical activity, MET-h/d	17.60 ± 11.50	5.51 ± 2.49	12.27 ± 1.68	18.87 ± 2.28	33.74 ± 8.85	<0.001
Sedentary leisure time, h/d	2.99 ± 1.72	3.11 ± 2.03	3.12 ± 1.76	2.94 ± 1.60	2.78 ± 1.41	<0.001
n (%)						
Demographic factors						
Female	20,932 (60.50)	5,095 (59.05)	5,705 (65.80)	5,136 (59.42)	4,996 (57.72)	<0.001
Rural	22,790 (65.87)	7,405 (85.83)	5,383 (62.09)	3,987 (46.12)	6,015 (69.50)	<0.001
Han Chinese ethnicity	34,198 (99.14)	8,558 (99.41)	8,575 (99.16)	8,513 (98.85)	8,552 (99.17)	0.020
Socioeconomic and lifestyle factors						
Middle school	13,647 (39.60)	4,068 (47.29)	2,949 (34.15)	2,517 (29.25)	4,113 (47.74)	<0.001
Married	30,285 (88.04)	7,699 (89.63)	7,330 (85.09)	7,464 (86.89)	7,792 (90.56)	<0.001
Household annual income ≥100,000 ¥/year [c]	4,631 (14.97)	462 (5.77)	1,254 (16.58)	2,056 (27.45)	859 (10.91)	<0.001
Current smoker	7,163 (20.91)	1,949 (22.77)	1,481 (17.28)	1,712 (20.03)	2,021 (23.56)	0.001
Current drinker	22,981 (66.72)	2,139 (24.90)	2,852 (33.06)	3,725 (43.31)	2,746 (31.84)	<0.001
Self-reported conditions						
Excellent status of health	11,261 (32.72)	2,211 (25.74)	2,891 (33.57)	3,223 (37.49)	2,936 (34.07)	<0.001
Hypertension	4,164 (37.50)	1,254 (35.42)	1,035 (37.28)	864 (35.35)	1,011 (43.13)	<0.001
Diabetes	997 (9.47)	304 (9.03)	257 (9.82)	209 (9.02)	227 (10.20)	0.281
MACE	1,048 (3.24)	420 (5.26)	265 (3.31)	173 (2.13)	190 (2.31)	<0.001

MET-h/d, metabolic equivalents of task per hour per day; SD, standard deviation; BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); MACE, major adverse cardiovascular event.

[a]For some variables, the sum of categories was not equal to the total due to missing data.

[b]Continuous variables were presented as Mean ± SD and categorical variables were presented as n (%).

[c]RMB (yuan) was used to estimate household annual income.

Statistical analysis

The value of MET was categorized into four groups according to quartile: <9.0 MET-h/d, 9.0–15.2 MET-h/d, 15.3–23.2 MET-h/d, and ≥23.3 MET-h/d. Selected characteristics of the study participants were compared by quartile of total PA. Sociodemographic characteristics are presented using the means ± standard deviation (SD) for continuous variables and the frequencies (percentage) for categorical variables. ANOVA and chi-square tests were used to test differences based on the quartile of MET.

Given that MACE was rare in the whole population, we used a penalized maximum likelihood logistic regression model to reduce the possible biases (32). We estimated the odds ratios (ORs) for MACE with a quartile of total PA (both continuous and categorical variables) with a 95% confidence interval (CI). PA results are presented as the ORs per 4 MET-h/d higher total PA with the risk of MACEs. Model 1 was fitted by a crude penalized maximum likelihood logistic regression model, with

only the MET value as the exposure. Model 2 was adjusted for sociodemographic factors (e.g., age, sex, study location, household annual income, and education). Model 3 was further adjusted for participants' lifestyle factors (e.g., smoking, alcohol consumption, sedentary leisure time, fruit intake, and self-reported general health status). We performed the same analysis on the secondary outcomes (AMI and stroke/minor stroke).

To explore the dose-response relationship between total PA and the risk of MACEs, we performed restricted cubic spline (RCS) with five knots (5th, 25th, 50th, 75th, and 95th) to explore the nonlinear relationship. The linearity of the dose-response association was tested using Wald tests (33). Age in the regression model using an RCS function was treated as a potential confounder, and the mean MET values were treated as reference spots. We further adjusted sociodemographic and lifestyle factors (Model 3) and excluded outliers (MET values that were outside three standard deviations from the mean). For subgroup analysis, we grouped the total sample by sex (males and females), age (years; 18–44, 45–59, and ≥60), BMI [kg/m^2;

normal weight (BMI < 24 kg/m^2), overweight (24 kg/m^2 ≤ BMI < 28 kg/m^2), and obesity (BMI ≥ 28 kg/m^2)], and region (urban region and rural region). In an exploratory analysis, we further grouped the total participants into two groups (with diabetes and without diabetes) to explore the effect of diabetes on the relationship between PA and MACE.

All statistical analyses were performed using SAS version 9.4 software (SAS Institute, Inc., Cary, NC). Penalized maximum likelihood estimation in logistic regression was conducted using SAS PROC LOGISTIC. Two-sided p-values < 0.05 were considered statistically significant.

Results

Overall, the distributions of sociodemographic and lifestyle factors in the analytic sample (n = 34,597) were considerably different from those in the excluded sample (n = 13,428; Supplementary Table 2). Specifically, participants in the analytic sample had a younger age, higher BMI level, longer sedentary leisure time, and higher household annual income. They were more likely to be female, had a lower proportion of smokers and drinkers, and had poor health status.

Table 1 illustrates the sociodemographic factors at baseline and lifestyle factors stratified into four groups by MET quartile. The sample covered ages from 18 to 90 years old (the mean ± SD age was 50.15 ± 12.81). The mean ± SD BMI value was 23.80 ± 3.40 kg/m^2, 60.50% (n = 20,932) were women, 65.87% (n = 22,790) were from rural regions, and 99.14% (n = 34,198) were of Han Chinese ethnicity. Individuals with higher total PA levels were younger, married, had a higher level of education, had higher levels of self-reported general health status, and were more likely to report hypertension than those with lower PA levels.

Table 2 shows the relationship between total PA and the risk of MACEs in all participants. Higher total PA (MET-h/d, continuous variables) was associated with a 5% lower risk of MACE [adjusted OR = 0.95 (95% CI, 0.93∼0.98), p-value < 0.001] in every increase of four MET-h/d after adjusting for sociodemographic and lifestyle factors. For categorical variables of total PA, which were categorized into four groups by quartile, individuals in the top quartile of total physical activity were associated with a 32% lower risk of MACE [adjusted OR = 0.68 (95% CI, 0.55∼0.83), p-value < 0.001] than those in the bottom quartile. In addition, we explored the dose-response relationship between total PA and the risk of MACEs in all participants (Figure 2). After adjustment for sociodemographic and lifestyle factors (Model 3), a higher level of total PA per day was associated with a lower risk of MACEs compared with the reference level (17.60 MET-h/d, $P_{overall}$ = 0.0012, $P_{non-linear}$ = 0.0512). The dose-response relationship showed a "U"-shaped association, with the 31.78 MET-h/d showing a 34% lower risk of MACEs [adjusted OR = 0.66 (95% CI, 0.52∼0.84)].

Additionally, we observed the similar results in the secondary outcomes (Supplementary Table 3). Throughout the range of total physical activity studied, each four MET-h/d higher usual total PA was associated with a 9% and 4% lower risk of AMI and stroke/minor stroke, respectively. There were similar results in the total PA quartile in this study's component of MACE.

In the subgroup analysis, we observed similar results in males, females, participants aged over 44 years old, those who had normal weight (BMI < 24 kg/m^2), and participants who lived in the rural region (Supplementary Tables 4–7). Specifically, in different sex groups, individuals in the top quartile of total physical activity were associated with a 27% lower risk of MACE [adjusted OR = 0.73 (95% CI, 0.56∼0.97), p-value = 0.028] and a 38% lower risk of MACE [adjusted OR = 0.62 (95% CI, 0.46∼0.82), p-value = 0.001] than those in the bottom quartile in males and females, respectively. However, the association between continuous variables of total PA and the risk of MACEs was only marginally significant in males [adjusted OR = 0.95 (95% CI, 0.94∼1.00), p-value = 0.045] after adjusting for sociodemographic and lifestyle factors. In different age groups, participants over 44 years old (including 45–59 years old and over 60 years old) showed a lower risk of MACEs with the increasing daily PA, similar to the normal-weight individuals' risk. For overweight participants, we only observed a 32% lower risk of MACEs when comparing the top quartile with the bottom quartile of total PA. We further observed the relationship between total PA and lower risk of MACE in participants who lived in the rural region. In contrast, there was no significant association among urban region individuals. The association between PA and MACE was observed in participants without diabetes at the baseline survey, both in continuous and categorical variables of PA, but not in participants with diabetes (Supplementary Table 8).

Discussion

Physical activity (PA) has been considered a simple, low-cost, and widely applicable approach to preventing MACEs (34). With data from 34,597 individuals from the baseline survey of the cohort study in Shaanxi Province, we observed that higher total PA per day was related to a lower risk of MACEs in all participants. The subgroup analyses showed similar results in males, females, participants over 44 years old, those with normal weight, and rural region individuals. In addition, there was a dose-response relationship between total PA and the risk of MACEs when total PA levels exceeded 17.60 MET-h/d. However, the results suggested that higher total PA might not be better when exploring the relationship with CVD because no further reductions were observed over ∼31.78 MET-h/d.

Prospective cohort analysis in US elderly adults proved that PA, mainly walking, was beneficial in reducing the incidence of coronary heart disease and stroke among elderly adults (35).

TABLE 2 Associations between total physical activity and the prevalence of MACE in all participants.

	Sample size	Prevalence, n (%)	Model 1 (crude)	p-value	Model 2[a]	p-value	Model 3[b]	p-value
			OR (95% CI)					
PA (MET-h/d)	32,338	1,048 (3.24)	0.89 (0.87, 0.91)	<0.001	0.95 (0.93, 0.98)	<0.001	0.95 (0.93, 0.98)	<0.001
PA (Quartile)[c]								
<9.0	7,992	420 (5.26)	1.00 [Reference]		1.00 [Reference]		1.00 [Reference]	
9.0–15.2	8,014	265 (3.31)	0.62 (0.53, 0.72)	<0.001	0.98 (0.83, 1.15)	0.782	1.03 (0.86, 1.22)	0.771
15.3–23.2	8,118	173 (2.13)	0.39 (0.33, 0.47)	<0.001	0.89 (0.73, 1.08)	0.223	0.88 (0.72, 1.08)	0.233
≥23.3	8,214	190 (2.31)	0.43 (0.36, 0.51)	<0.001	0.67 (0.56, 0.82)	<0.001	0.68 (0.55, 0.83)	<0.001

MACE, major adverse cardiovascular event; MET-h/d, metabolic equivalents of task per hour per day; OR, odds ratio; CI, confidence interval.
[a] Model 2 adjusted for age, sex, study location, household annual income, and education.
[b] Model 3 additionally adjusted for smoking, alcohol consumption, sedentary leisure time, fruit intake, and self-reported general health status.
[c] The value of METs was categorized into four groups by quartile: 9.0 (quartile1), 15.2 (quartile2), 23.2 (quartile3).
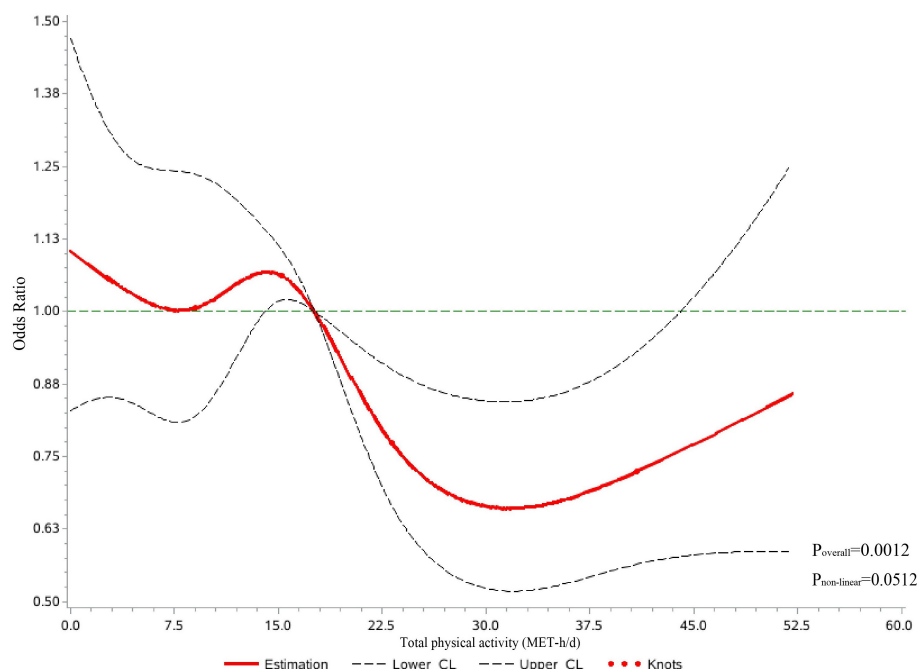

FIGURE 2
Dose-response relationship between total physical activity per day and major adverse cardiovascular events in restricted cubic spline among all participants. CL, confidence limit; MET-h/d, metabolic equivalents of task per hour per day. Curves were fitted as a smooth term using a restricted cubic spline with five knots (5th, 25th, 50th, 75th, and 95th). Age in the regression model using an RCS function was treated as a potential confounder, and the mean MET values were treated as reference spots. The model was adjusted for sociodemographic factors (e.g., sex, study location, household annual income, and education) and participants' lifestyle factors (e.g., smoking, alcohol consumption, sedentary leisure time, fruit intake, and self-reported general health status).

Additionally, a community-based sample of adults from the electronic Framingham Heart Study (eFHS) in the US reported that every increase of 1,000 steps in habitual physical activity was related to a 0.2% lower predicted CVD risk (p-value = 3.2×10^{-4}) (36). A Chinese population-based prospective cohort study found a negative relationship between total PA and the risk of major vascular events, with an adjusted hazard ratio that compared the top (≥33.8 MET-h/d) with the bottom (≤9.1 MET-h/d) quintiles of PA at 0.77 (95% CI, 0.74∼0.80) (18). Results in this study were in line with available evidence from previous studies, with an adjusted OR of 0.95 (95% CI, 0.93∼0.98) in all participants.

However, the most recent global comparative study from 2018 indicates that one in four adults did not meet the World Health Organization (WHO) recommendations on PA to benefit from improving their health and wellbeing (37). This is mainly

because of dramatic urbanization, reduction in PA in the workplace, changes in modes of transport, and other aspects of lifestyle, including in China (38, 39). Although we found that every four MET-h/d increase in PA was related to a lower risk of MACEs, our results might suggest a threshold association between total PA and the risk of MACEs. However, given that this study was based on cross-sectional data, we could not prove the causality. Some studies have reported that extreme endurance exercise may be detrimental to cardiovascular health (40), but the extent to which this may be relevant to the general population is unclear. A study based on objectively measured PA from a large population-based cohort study found no evidence of a threshold for the inverse association between objectively measured moderate, vigorous, and total PA and CVD (41). One potential reason might be related to the intensity of PA in total PA. A prospective cohort study of UK Biobank participants reported that a higher level of moderate-intensity PA was related to a lower risk of heart failure even beyond the current WHO PA recommendations. However, vigorous-intensity PA might have a lower potential risk reduction of heart failure when it exceeds the guidelines (42).

The benefits of PA have been proven at both biological and disease-specific levels. Biologically, many studies have demonstrated that PA can attenuate cardiovascular changes by improving the functional capacity of the cardiovascular system, cardiac function (43), and metabolism (44). A community-based study in the United States found that higher PA levels were associated with proportionally greater left ventricular mass and end-diastolic volume and lower resting heart rate among populations free of clinically apparent cardiovascular disease (43). In addition, some studies revealed that some cellular pathways (e.g., the insulin-like growth factor 1/PI3K/Akt pathway and nitric oxide signaling pathway) (45) and molecular mechanisms were associated with the positive effect of PA on cardiovascular disease. For example, experimental studies on rats revealed that the expression of cardiac heat shock protein 72 (HSP72) was robustly activated by exercise, promoting cardio-protection against ischemia-reperfusion injury (46).

Females appeared to have a more significant association between total PA per day and the risk of MACEs than males in this study, which was in line with a previous study (10, 18, 47). A meta-analysis of 21 prospective studies showed that moderate levels of occupational PA were related to more significant effects in females, especially coronary heart disease, compared with males (10). One possible explanation for the difference between males and females is that the women's reported physical activity may have occurred against a higher "background" level of activity in terms of routine household tasks (e.g., preparing meals, doing laundry, and light housework) and caring duties (47). A multistage study in Australia reported that men aged 40–65 years old spend 3.96 h on a usual weekday and 4.93 h on a typical weekend day in sedentary leisure behavior (e.g., watching television and using a computer at home), which is higher than

their female counterparts (48). These differing "background" levels of light activity and sedentary behavior may be critical regarding long-term health outcomes (49).

In addition, we observed a difference in age groups, with participants over 45 years showing a beneficial relationship between total PA per day and the risk of MACE, which was in line with a prior study. A study based on the European Prospective Investigation into Cancer (EPIC) Norfolk prospective population study reported that there was a significant inverse association between PA and the risk of CVD when comparing individuals with the highest level of PA to inactive people in the elderly (>65 years) and people aged 55–65 years old (50). In the BMI groups, we found an association between total PA per day and a lower risk of MACEs in those participants with average weight after adjusting for sociodemographic factors and lifestyle factors. Obese individuals have lower relative muscle strength than non-obese individuals and have an increased risk of musculoskeletal injury/pathology (51). A previous study reported that PA did not eliminate the risk of CVD associated with elevated BMI. However, physical activity attenuated the increased risk of obesity in relatively healthy populations (52). Furthermore, in the exploratory analysis, we only observed the association between total PA per day and a lower risk of MACE in the individuals who did not have diabetes but were not individuals with diabetes. The results were inconsistent with the current study. A population-based cohort of patients with type 2 diabetes reported that the active patient (obtained from the primary care records and evaluated by nurse practitioners) had a 29% lower risk of CVD events than the inactive group (53). The inconsistency in the results might have the following reasons: firstly, the outcomes of CVD and diabetes were self-reported. Due to the lower access to health services and chronic disease management levels in northwest China, the overall prevalence of self-reported diabetes and CVD was low in this cohort's baseline survey (22). Besides, this study is a cross-sectional design, which means it is difficult to explain the temporal of diabetes and CVD.

The major strength of this study is the large population sample recruited from Shaanxi Province in northwest China. We collected a sizable number of outcomes to investigate the relationship between total PA and the risk of MACEs. In addition, we quantified the amount of PA and assessed the risk of MACEs with which it was associated. Moreover, we examined the associations by adjusting for a comprehensive list of confounders, including sociodemographic factors and lifestyle factors, to reduce the potential confounding bias.

This study also had several limitations. First, this cross-sectional study could not prove the causality between PA and the risk of MACEs and had the risk of reverse causality between them. The objective measurement or continuous monitoring of PA levels between exposure and outcome would allow for more accurate conclusions and is a focus of future work. Second, we used a questionnaire to collect data about daily activity. Due to

differential measurement errors of self-reported questionnaires and incomplete coverage of PA types, there was uncertainty about the strength of this association (41). A study from a nationally representative sample of United States adults found that MVPA measured using accelerometers showed a stronger relationship with physiological and anthropometric biomarkers than self-reported MVPA (54). In addition, a multicenter study involving 10 regional test centers throughout Norway reported that the correlation coefficients between the International Physical Activity Questionnaire and objectively measured PA (by accelerometers) ranged from 0.20 to 0.46. Higher activity and intensity levels might be related to the increased difference between self-reported and accelerometer-measured MVPA (55). Thus, misreporting activity levels might have led to potential bias in the relationship between PA and the risk of MACE compared with objective PA measurement. However, for our study's large population, self-reported questionnaires still have some advantages, e.g., they are easy to manage during the data collection, are low-cost, and can collect detailed information on the activities performed (56). In addition, the primary outcome of this analysis was also collected by questionnaire, which cannot fully reflect the clinical outcomes of major cardiovascular events. Third, although we adjusted for confounders among sociodemographic and lifestyle factors, there might have still been residual confounding because of unknown and unmeasured factors (e.g., lipids, medication history, and the use of pharmacological treatments) or bias (e.g., recall bias). Thus, future research should focus on objective indicators to evaluate the effect of PA on CVD, such as cardiorespiratory fitness (57) and cardio-metabolic risk biomarkers (58). Finally, given that the mean age in this study was 50.15 years, the findings might not be generalizable to younger populations.

Controlling the lifestyle of CVD, including diet and physical activity, and reducing their geographical inequity should be critical points in addressing the daunting CVD burden in China (59). However, compared with central and eastern China, the region of northwest China had low economic and medical levels and unhealthy lifestyle behavior, which were the influence factors in the prevention of CVD (22). Our study results might help to give a clue in developing regional CVD prevention guidelines. To be more practical, we observed each four MET-h/d higher activity (~1 h of brisk walking per day) was associated with a 5% lower risk of MACE. Further research is needed to explore the causality between PA and the incidence of CVD in northwest China.

Conclusions

In conclusion, higher levels of total PA were related to lower risks of MACEs in adults from northwest China. In addition, there was a "U"-shaped dose-response relationship between total PA and the risk of MACEs when total

PA exceeded 17.60 MET-h/d. Future prospective studies should focus on device-measured PA (e.g., accelerometers or pedometers) or domain-specific PA (e.g., leisure-time PA and occupational PA), providing robust evidence to develop PA guidelines as an effective intervention strategy for CVD in the Chinese population.

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 Human Research Ethics Committee of Xi'an Jiaotong University. The patients/participants provided their written informed consent to participate in this study.

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YW and BM designed the study. YW, HL, and BM designed the analytical strategy and helped to interpret the findings and wrote the paper. BM had primary responsibility for the final content. DH, BZ, YL, KX, SC, YH, JL, LZ, HY, and SD provided additional interpretation of the data and revisions to the manuscript. All authors have read and approved the final manuscript.

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Conflict of interest

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

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpubh.2022.1025670/full#supplementary-material

References

1. Poudel I, Tejpal C, Rashid H, Jahan N. Major adverse cardiovascular events: an inevitable outcome of ST-elevation myocardial infarction? A literature review. *Cureus.* (2019) 11:e5280. doi: 10.7759/cureus.5280

2. Lee IM, Shiroma EJ, Lobelo F, Puska P, Blair SN, Katzmarzyk PT, et al. Effect of physical inactivity on major non-communicable diseases worldwide: an analysis of burden of disease and life expectancy. *Lancet.* (2012) 380:219–29. doi: 10.1016/S0140-6736(12)61031-9

3. Onder G, Giovannini S, Sganga F, Manes-Gravina E, Topinkova E, Finne-Soveri H, et al. Interactions between drugs and geriatric syndromes in nursing home and home care: results from shelter and ibenc projects. *Aging Clin Exp Res.* (2018) 30:1015–21. doi: 10.1007/s40520-018-0893-1

4. Castelli L, De Giglio L, Haggiag S, Traini A, De Luca F, Ruggieri S, et al. Premorbid functional reserve modulates the effect of rehabilitation in multiple sclerosis. *Neurol Sci.* (2020) 41:1251–7. doi: 10.1007/s10072-019-04237-z

5. Laudisio A, Giovannini S, Finamore P, Loreti C, Vannetti F, Coraci D, et al. Muscle strength is related to mental and physical quality of life in the oldest old. *Arch Gerontol Geriatr.* (2020) 89:104109. doi: 10.1016/j.archger.2020.104109

6. Giovannini S, Macchi C, Liperoti R, Laudisio A, Coraci D, Loreti C, et al. Association of body fat with health-related quality of life and depression in nonagenarians: the mugello study. *J Am Med Dir Assoc.* (2019) 20:564–8. doi: 10.1016/j.jamda.2019.01.128

7. Laudisio A, Antonelli Incalzi R, Gemma A, Giovannini S, Lo Monaco MR, Vetrano DL, et al. Use of proton-pump inhibitors is associated with depression: a population-based study. *Int Psychogeriatr.* (2018) 30:153–9. doi: 10.1017/S1041610217001715

8. Li S, Liu Z, Joseph P, Hu B, Yin L, Tse LA, et al. Modifiable risk factors associated with cardiovascular disease and mortality in China: a pure substudy. *Eur Heart J.* (2022) 43:2852–63. doi: 10.1093/eurheartj/ehac268

9. Lv J, Yu C, Guo Y, Bian Z, Yang L, Chen Y, et al. Adherence to healthy lifestyle and cardiovascular diseases in the Chinese population. *J Am Coll Cardiol.* (2017) 69:1116–25.

10. Li J, Siegrist J. Physical activity and risk of cardiovascular disease–a meta-analysis of prospective cohort studies. *Int J Environ Res Public Health.* (2012) 9:391–407. doi: 10.3390/ijerph9020391

11. Li X, Wu C, Lu J, Chen B, Li Y, Yang Y, et al. Cardiovascular risk factors in China: a nationwide population-based cohort study. *Lancet Public Health.* (2020) 5:e672–81. doi: 10.1016/S2468-2667(20)30191-2

12. Yang G, Wang Y, Zeng Y, Gao GF, Liang X, Zhou M, et al. Rapid health transition in China, 1990-2010: findings from the global burden of disease study 2010. *Lancet.* (2013) 381:1987–2015. doi: 10.1016/S0140-6736(13)61097-1

13. Kwan GF, Mayosi BM, Mocumbi AO, Miranda JJ, Ezzati M, Jain Y, et al. Endemic cardiovascular diseases of the poorest billion. *Circulation.* (2016) 133:2561–75. doi: 10.1161/CIRCULATIONAHA.116.008731

14. Yusuf S, Hawken S, Ounpuu S, Dans T, Avezum A, Lanas F, et al. Effect of potentially modifiable risk factors associated with myocardial infarction in 52 countries (the Interheart Study): Case-Control Study. *Lancet.* (2004) 364:937–52. doi: 10.1016/S0140-6736(04)17018-9

15. Piercy KL, Troiano RP, Ballard RM, Carlson SA, Fulton JE, Galuska DA, et al. The physical activity guidelines for Americans. *JAMA.* (2018) 320:2020–8. doi: 10.1001/jama.2018.14854

16. Fiuza-Luces C, Santos-Lozano A, Joyner M, Carrera-Bastos P, Picazo O, Zugaza JL, et al. Exercise benefits in cardiovascular disease: beyond attenuation of traditional risk factors. *Nat Rev Cardiol.* (2018) 15:731–43. doi: 10.1038/s41569-018-0065-1

17. Holtermann A, Schnohr P, Nordestgaard BG, Marott JL. The physical activity paradox in cardiovascular disease and all-cause mortality: the contemporary Copenhagen general population study with 104 046 adults. *Eur Heart J.* (2021) 42:1499–511. doi: 10.1093/eurheartj/ehab087

18. Bennett DA, Du H, Clarke R, Guo Y, Yang L, Bian Z, et al. Association of physical activity with risk of major cardiovascular diseases in Chinese men and women. *JAMA Cardiol.* (2017) 2:1349–58. doi: 10.1001/jamacardio.2017.4069

19. Pandey A, Patel M, Gao A, Willis BL, Das SR, Leonard D, et al. Changes in Mid-life fitness predicts heart failure risk at a later age independent of interval development of cardiac and noncardiac risk factors: the cooper center longitudinal study. *Am Heart J.* (2015) 169:290–7.e1. doi: 10.1016/j.ahj.2014.10.017

20. Li F. Physical activity and health in the presence of China's economic growth: Meeting the public health challenges of the aging population. *J Sport Health Sci.* (2016) 5:258–69. doi: 10.1016/j.jshs.2016.06.004

21. Chun L, Limin W, Xiao Z, Zhenping Z, Zhengjing H, Maigeng Z, et al. Leisure-time physical activity among Chinese adults — China, 2015. *China CDC Weekly.* (2020) 2:671–7. doi: 10.46234/ccdcw2020.187

22. Li C, Liu Y, Shi G, Mi B, Zeng L, Li Q, et al. Cohort profile: regional ethnic cohort study in Northwest China. *Int J Epidemiol.* (2022) 51:e18–26. doi: 10.1093/ije/dyab212

23. Wareham NJ, Jakes RW, Rennie KL, Mitchell J, Hennings S, Day NE. Validity and repeatability of the epic-norfolk physical activity questionnaire. *Int J Epidemiol.* (2002) 31:168–74. doi: 10.1093/ije/31.1.168

24. Matthews CE, Shu XO, Yang G, Jin F, Ainsworth BE, Liu D, et al. Reproducibility and validity of the Shanghai women's health study physical activity questionnaire. *Am J Epidemiol.* (2003) 158:1114–22. doi: 10.1093/aje/kwg255

25. Du H, Bennett D, Li L, Whitlock G, Guo Y, Collins R, et al. Physical activity and sedentary leisure time and their associations with bmi, waist circumference, and percentage body fat in 05 million adults: the China Kadoorie Biobank Study. *Am J Clin Nutr.* (2013) 97:487–96. doi: 10.3945/ajcn.112.046854

26. Ainsworth BE, Haskell WL, Herrmann SD, Meckes N, Bassett DR Jr., Tudor-Locke C, et al. 2011 compendium of physical activities: a second update of codes and met values. *Med Sci Sports Exerc.* (2011) 43:1575–81. doi: 10.1249/MSS.0b013e31821ece12

27. Caspersen CJ, Powell KE, Christenson GM. Physical activity, exercise, and physical fitness: definitions and distinctions for health-related research. *Public Health Rep.* (1985) 100:126–31.

28. Zhou BF, Cooperative Meta-Analysis Group of the Working Group on Obesity in C. Predictive values of body mass index and waist circumference for risk factors of certain related diseases in Chinese adults–study on optimal cut-off points of body mass index and waist circumference in Chinese Adults. *Biomed Environ Sci.* (2002) 15:83–96. doi: 10.1046/j.1440-6047.11.s8.9.x

29. Zhou P, Hughes AK, Grady SC, Fang L. Physical activity and chronic diseases among older people in a mid-size city in China: a longitudinal investigation of bipolar effects. *BMC Public Health.* (2018) 18:486. doi: 10.1186/s12889-018-5408-7

30. Textor J, van der Zander B, Gilthorpe MS, Liskiewicz M, Ellison GT. Robust causal inference using directed acyclic graphs: the R package 'dagitty'. *Int J Epidemiol.* (2016) 45:1887–94. doi: 10.1093/ije/dyw341

31. Currie CJ, Berni ER, Berni TR, Jenkins-Jones S, Sinsakul M, Jermutus L, et al. Major adverse cardiovascular events in people with chronic kidney disease in relation to disease severity and diabetes status. *PLoS ONE.* (2019) 14:e0221044. doi: 10.1371/journal.pone.0221044

32. Anderson JA, Blair V. Penalized maximum likelihood estimation in logistic regression and discrimination. *Biometrika.* (1982) 69:123–36. doi: 10.1093/biomet/69.1.123

33. Discacciati A, Crippa A, Orsini N. Goodness of fit tools for dose-response meta-analysis of binary outcomes. *Res Synth Methods.* (2017) 8:149–60. doi: 10.1002/jrsm.1194

34. Lear SA, Yusuf S. Physical activity to prevent cardiovascular disease: a simple, low-cost, and widely applicable approach for all populations. *JAMA Cardiol.* (2017) 2:1358–60. doi: 10.1001/jamacardio.2017.4070

35. Soares-Miranda L, Siscovick DS, Psaty BM, Longstreth WT Jr., Mozaffarian D. Physical activity and risk of coronary heart disease and stroke in older adults: the Cardiovascular Health Study. *Circulation.* (2016) 133:147–55. doi: 10.1161/CIRCULATIONAHA.115.018323

36. Lin H, Sardana M, Zhang Y, Liu C, Trinquart L, Benjamin EJ, et al. Association of habitual physical activity with cardiovascular disease risk. *Circ Res.* (2020) 127:1253–60. doi: 10.1161/CIRCRESAHA.120.317578

37. Guthold R, Stevens GA, Riley LM, Bull FC. Worldwide trends in insufficient physical activity from 2001 to 2016: a pooled analysis of 358 population-based surveys with 1.9 million participants. *Lancet Glob Health.* (2018) 6:e1077–e86. doi: 10.1016/S2214-109X(18)30357-7

38. Ng SW, Howard AG, Wang HJ, Su C, Zhang B. The physical activity transition among adults in China: 1991-2011. *Obes Rev.* (2014) 15(Suppl 1):27–36. doi: 10.1111/obr.12127

39. Ozemek C, Lavie CJ, Rognmo O. Global physical activity levels - need for intervention. *Prog Cardiovasc Dis.* (2019) 62:102–7. doi: 10.1016/j.pcad.2019.02.004

40. O'Keefe JH. Lavie CJ. Run for your life…at a comfortable speed and not too far. *Heart.* (2013) 99:516–9. doi: 10.1136/heartjnl-2012-302886

41. Ramakrishnan R, Doherty A, Smith-Byrne K, Rahimi K, Bennett D, Woodward M, et al. Accelerometer measured physical activity and the incidence of cardiovascular disease: evidence from the Uk Biobank Cohort Study. *PLoS Med.* (2021) 18:e1003487. doi: 10.1371/journal.pmed.1003487

42. Ho FK, Zhou Z, Petermann-Rocha F, Para-Soto S, Boonpor J, Welsh P, et al. Association between device-measured physical activity and incident heart failure: a Prospective Cohort Study of 94 739 Uk Biobank participants. *Circulation.* (2022) 146:883–91. doi: 10.1161/CIRCULATIONAHA.122.059663

43. Turkbey EB, Jorgensen NW, Johnson WC, Bertoni AG, Polak JF, Diez Roux AV, et al. Physical activity and physiological cardiac remodelling in a community setting: the Multi-Ethnic Study of Atherosclerosis (MESA). *Heart.* (2010) 96:42–8. doi: 10.1136/hrt.2009.178426

44. Jakovljevic DG. Physical activity and cardiovascular aging: physiological and molecular insights. *Exp Gerontol.* (2018) 109:67–74. doi: 10.1016/j.exger.2017.05.016

45. Schuttler D, Clauss S, Weckbach LT, Brunner S. Molecular mechanisms of cardiac remodeling and regeneration in physical exercise. *Cells.* (2019) 8:1128. doi: 10.3390/cells8101128

46. Hamilton KL, Staib JL, Phillips T, Hess A, Lennon SL, Powers SK. Exercise, antioxidants, and Hsp72: protection against myocardial ischemia/reperfusion. *Free Radic Biol Med.* (2003) 34:800–9. doi: 10.1016/S0891-5849(02)01431-4

47. Brown WJ, McLaughlin D, Leung J, McCaul KA, Flicker L, Almeida OP, et al. Physical activity and all-cause mortality in older women and men. *Br J Sports Med.* (2012) 46:664–8. doi: 10.1136/bjsports-2011-090529

48. Burton NW, Khan A, Brown WJ, Turrell G. The association between sedentary leisure and physical activity in middle-aged adults. *Br J Sports Med.* (2012) 46:747–52. doi: 10.1136/bjsm.2010.081430

49. Brown WJ, Bauman AE, Owen N. Stand up, sit down, keep moving: turning circles in physical activity research? *Br J Sports Med.* (2009) 43:86–8. doi: 10.1136/bjsm.2008.055285

50. Lachman S, Boekholdt SM, Luben RN, Sharp SJ, Brage S, Khaw KT, et al. Impact of physical activity on the risk of cardiovascular disease in middle-aged and older adults: epic norfolk prospective population study. *Eur J Prev Cardiol.* (2018) 25:200–8. doi: 10.1177/2047487317737628

51. Lerner ZF, Board WJ, Browning RC. Effects of obesity on lower extremity muscle function during walking at two speeds. *Gait Posture.* (2014) 39:978–84. doi: 10.1016/j.gaitpost.2013.12.020

52. Weinstein AR, Sesso HD, Lee IM, Rexrode KM, Cook NR, Manson JE, et al. The joint effects of physical activity and body mass index on coronary heart disease risk in women. *Arch Intern Med.* (2008) 168:884–90. doi: 10.1001/archinte.168.8.884

53. Enguita-German M, Tamayo I, Galbete A, Librero J, Cambra K, Ibanez-Beroiz B. Effect of physical activity on cardiovascular event risk in a population-based cohort of patients with type 2 diabetes. *Int J Environ Res Public Health.* (2021) 18:12370. doi: 10.3390/ijerph182312370

54. Atienza AA, Moser RP, Perna F, Dodd K, Ballard-Barbash R, Troiano RP, et al. Self-reported and objectively measured activity related to biomarkers using Nhanes. *Med Sci Sports Exerc.* (2011) 43:815–21. doi: 10.1249/MSS.0b013e31813fdfc32

55. Dyrstad SM, Hansen BH, Holme IM, Anderssen SA. Comparison of self-reported versus accelerometer-measured physical activity. *Med Sci Sports Exerc.* (2014) 46:99–106. doi: 10.1249/MSS.0b013e3182a0595f

56. Troiano RP, Pettee Gabriel KK, Welk GJ, Owen N, Sternfeld B. Reported physical activity and sedentary behavior: why do you ask? *J Phys Act Health*. (2012) 9(Suppl 1):S68–75. doi: 10.1123/jpah.9.s1.s68

57. Celis-Morales CA, Lyall DM, Anderson J, Iliodromiti S, Fan Y, Ntuk UE, et al. The association between physical activity and risk of mortality is modulated by grip strength and cardiorespiratory fitness: evidence from 498 135 Uk-Biobank participants. *Eur Heart J.* (2017) 38:116–22. doi: 10.1093/eurheartj/ehw249

58. Healy GN, Winkler EA, Owen N, Anuradha S, Dunstan DW. Replacing sitting time with standing or stepping: associations with cardio-metabolic risk biomarkers. *Eur Heart J.* (2015) 36:2643–9. doi: 10.1093/eurheartj/ehv308

59. Liu S, Li Y, Zeng X, Wang H, Yin P, Wang L, et al. Burden of cardiovascular diseases in China, 1990-2016: findings from the 2016 Global Burden of Disease Study. *JAMA Cardiol.* (2019) 4:342–52. doi: 10.1001/jamacardio.2019.0295

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Perception of men's need for preconception care—A qualitative exploration among health care providers and community members

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Background: Several studies have shown that suboptimal health in men can result in poor reproductive health outcomes. The factors associated include lifestyle exposures and poor health-seeking behavior. The poor reproductive health outcomes can be mitigated through preconception care (PCC). PCC services for men are however rare. This qualitative study explored views about men's need for PCC in Nigeria.

Methods: This exploratory qualitative study was done in Ibadan North Local Government Area, Oyo State, Nigeria. Focus group discussions were held with 12 religious leaders, 22 men and 23 women of reproductive age at the community level. There were key informant interviews with two community leaders and 26 health workers including specialist physicians and nurses at the primary, secondary, and tertiary health care levels. Transcribed data were analyzed thematically using inductive coding on MAXQDA.

Results: The reasons participants proffered for men's health requiring attention included men's genetic contribution to pregnancy, treatment of low sperm count, and preventing transmission of infection to their partners. Participants stated however that men are often reluctant about accessing health services until complications arise. Opinions differed on men's need for PCC: while some believed that men need PCC, others expressed contrary views stating that men do not require PCC as the service is more appropriate for women.

Conclusion: Successful deployment and uptake of PCC services require the availability of the services and improved awareness about the need to optimize men's health along with that of their partners.

Introduction

The preconception period refers to the time when a couple of reproductive age has the potential to achieve conception (1). The concept of preconception health refers to an individual's biopsychosocial wellness during the preconception period (1, 2). Preconception care (PCC) is the provision of biomedical, behavioral, and social health interventions to women and couples before conception occurs, aimed at improving their health status, and reducing behaviors and individual and environmental factors that could contribute to poor maternal and child health outcomes (3, 4). Although women have been the target of PCC programs, the importance of PCC for men is gaining momentum because their preconception health affects their biological, and genetic contributions to pregnancy outcomes (5–7). PCC interventions for men include a reproductive health plan, health assessment, health promotion, and clinical and psychosocial interventions to improve adolescent and young men's health (5, 8–10). PCC for men serves a dual function—it optimizes men's overall health through disease prevention and health promotion interventions and encourages them to support women's preconception health status and reproductive plans (5, 10–13). Men also need reproductive planning with their partners, a component of PCC that assists individuals and couples to decide if, when, and how many children they want to have while ensuring health is optimized before conception (14, 15). Additionally, involving men in reproductive life planning through preconception counseling can ensure better preparation for parental responsibilities and improve reproductive health outcomes by encouraging positive perinatal care choices and health-seeking behavior while supporting maternal health decisions (7). More importantly, PCC for men is an opportunity to improve men's overall health through health promotion and disease prevention interventions (5).

Male involvement in reproductive health issues has however been hampered by men's view that women have more rights in reproductive health since they are the ones who get pregnant (16, 17). Studies among men in the United Kingdom, the United States, and Netherlands reported that men believed they do not have a voice in reproductive health issues, and as such discussions typically focus on women (16–18). A systematic review of studies on men's knowledge and attitudes toward fertility issues revealed that men generally have poor knowledge about fertility and the factors that can influence conception (19). Several studies have however shown that environmental and lifestyle exposures in men are associated with changes in the sperm genome (7, 10, 20–22). These changes have been linked with low sperm motility, increased time to pregnancy in partners, the subsequent occurrence of birth defects, and a negative impact on the future health of children (7, 10, 22, 23). The implicated environmental exposures and lifestyle issues can be addressed during the preconception period, a critical window when both paternal and maternal health can be optimized to improve reproductive health outcomes (24, 25).

Beyond optimizing men's health, reproductive planning is an important aspect of PCC in paternalistic societies like Nigeria where men often desire more children than women. The 2018 Nigeria Demographic and Health Survey (NDHS) reported that men desired at least one child more on average compared with women (26). PCC through reproductive planning can open up conversations around fertility preferences and address the discrepancy in the desire for more children among couples (27). This is particularly critical given that parenthood is culturally believed to signify maturity in many Nigerian communities and is only socially acceptable within marriage (28–30). Within the community setting in Nigeria therefore, and among the Christian and Islamic religious bodies, anecdotal reports state that leaders often provide premarital counseling to couples who are preparing for marriage. Some of the content of the counseling has been reported to include aspects of preconception care (30).

PCC services are however not yet established in many low- and middle-income countries (LMICs) including Nigeria. Existing PCC studies have assessed the provision of PCC by health workers and uptake among women of reproductive age. Evidence shows that where available, PCC services are provided opportunistically or as requested by clients, who are mostly women (30, 31). There is still a gap in the understanding of PCC services for men. With the increasing awareness of the vital role men play in reproductive health, it is critical to include men in conversations about PCC while the services are in the initial stages of development and deployment. This study, therefore, explored the perception about men's need for PCC among adult men and women, religious and community leaders, and health care providers in Nigeria. The data for this article is part of a study that explored the need for and feasibility of PCC services within the Nigerian health system.

Materials and methods

This exploratory qualitative study followed an ontological assumption that each potential participant has a different understanding of men's need for PCC based on their personal experiences (32). The exploration, therefore, shows multiple perspectives about men's need for PCC in Nigeria. The views of different individuals within the health system and at the community level are presented as themes developed from the data (32). The study employed focus group discussions (FGDs) and key informant interviews (KIIs). The findings are triangulated with emphasis placed on the practical implications of these varying perspectives (32–34).

Study area

Politically, Nigeria is divided into 36 states and the federal capital territory. Oyo State where the study was done is located in the southwest and has 33 local government areas (LGAs), five of which are within Ibadan, the capital city. The study was conducted in Ibadan North LGA, one of the urban LGAs selected because it has health facilities at the primary, secondary, and tertiary levels of care. The Nigerian health system operates at three levels of specialization increasing from primary to secondary and tertiary. The services provided in the Nigerian health care system include basic health services including primary prevention and treatment of minor ailments at the primary level. The primary health centers are located at the ward level of political administration and are supervised by Ward Development Committees as part of the community participation arm of primary health care (35, 36). Specialized care is offered at the secondary and tertiary levels of health care (37, 38). There is a two-way referral system through which patients are referred to higher levels when more specialized services are needed or stepped down to lower levels when the specialized services are no longer required (35, 36). The roles played by the health workers at the three levels, therefore, increase in complexity depending on whether they are at the primary, secondary or tertiary level of health care.

Study population and participant selection

The study population included health workers at the primary, secondary, and tertiary levels of care as well as community members including community and religious leaders. Details of the participant distribution are shown in Table 1. The health workers were purposively selected based on their specialties and roles in providing health services to men and women in the reproductive age bracket. Recruitment of health care workers at the three levels of care was to ensure adequate representation of the varying roles within the health system. The specialties represented in the study sample are shown in Table 1. The number of participants at the three levels reflects the distribution of health workers within the health system in the selected LGA. Inclusion of community and religious leaders was because of their involvement in providing premarital counseling within their communities and religious organizations. The community leaders recruited for this study were identified from the Ward Development Committee overseeing the primary health care center within the study area. The religious leaders were recruited through the local branch of the national umbrella Christian and Muslim organizations. The community leaders

TABLE 1 Distribution of the study population.

Groups	Sub-groups		No
Community level	Adult women		23
	Adult men		22
Community leaders	Woman		1
	Man		1
Religious leaders	Christian		7
	Muslim		5
Health workers	Primary	Medical Officer of Health	1
		Assistant director for maternal and child health services	1
		Clinical nurse/midwife in the LGA primary health center	1
	Secondary	Gynecologist/Obstetrician	2
		Pediatrician	1
		Clinical nurse/midwife	2
	Tertiary	Community Medicine	2
		Gynecology and obstetrics	2
		Pediatrics	2
		Cardiology	1
		Nephrology	1
		Neurology	1
		Endocrinology	1
		Psychiatry	1
		Hematology	1
		Public Health nurse	3
		Clinical nurse	3
Total			**85**

assisted with the recruitment of the community members purposively selecting men and women between 18 and 49 years.

Data collection

Using information obtained from PCC literature, interview guides with open-ended questions were prepared for the study. The guides for the community-level interviews were translated into Yoruba, the local language and back-translated to ensure consistency of meaning. Two qualitative researchers participated in the content validation of the tools, after which the guides were pretested, and ambiguous questions deleted or modified before data collection. The participants selected their preferred language for the interviews/discussions and the version of the tool used (English or Yoruba) depended on their selection.

As an introductory question, the health workers were asked "In your opinion, do women of childbearing age require care that is different in any way from other patients who are seen in your practice? How about men between ages 15 and 59 years?" For the FGD participants at the community level, the introductory question was "What are the things that you believe are important for the health of couples who are trying to have a baby?" The participants were then asked to provide their opinion about what PCC involves—definitions and components. These findings have been published elsewhere (30).

For clarity and consistency across the interviews and for the diverse study participants, the following explanation of PCC was provided: Preconception care is a special type of care provided for women of reproductive age before pregnancy to detect, treat or counsel them about pre-existing medical and social conditions that can endanger pregnancy. Preconception care for men is also important as their health affects their biologic and genetic contributions to pregnancy outcomes. The goal of preconception care is to ensure that the parents are in an optimal state of health before pregnancy occurs. It includes screening, counseling, and treatment of pre-existing medical conditions as well as reproductive life planning. Following this description, the participants were asked to provide their opinion about the relevance of PCC services to men's health. The probes applied in reference to the explanation of PCC provided included: "To what extent would you say an understanding of preconception care is important to men's health? In your opinion, how much do men require distinct preconception care services?"

The first author supervised the data collection. Having worked with many of the health care providers previously, she did not participate directly in the data collection to avoid influencing the participants' responses. A team of research assistants including Masters Students and recent Masters Graduates in the Faculty of Public Health of the University of Ibadan, Nigeria facilitated the face-to-face interviews between March and October 2018. To ensure consistency in the data collection, the same set of facilitators conducted the IDIs and FGDs. The facilitators included three women and three men working in pairs who had prior experience in conducting qualitative interviews but no prior experience in PCC services. A 1-day training aimed specifically at familiarizing the research assistants with the concept of PCC and the data collection tools was held before data collection. The male facilitators led the interviews and FGDs with the male participants while the female facilitators led the interviews and FGDs with the female participants. The facilitators made field notes which were discussed during the debriefing meetings held with the first author for feedback, review, and planning of subsequent interviews. None of the research assistants had any prior relationship with the study participants. The interviews were

conducted at a location of preference for the participants, a venue within the community for the FGDs, and the offices of the health workers. The discussions and interviews lasted between 30 min to an hour. There were eight focus group discussions (FGDs) with the community members who were grouped by sex (male and female), marital status (single and married), and educational status (basic education and above and less than basic education). This categorization of participants at the community level was to ensure some homogeneity and encourage freedom of expression during the discussions (39, 40). Two FGDs were held with the religious leaders (Christian and Muslim), two in-depth interviews (IDIs) with the community leaders (male and female), and 26 IDIs with the health care providers. Data collection was discontinued when new information was no longer being obtained from the interviews implying that saturation had been achieved (41).

Data management and analysis

The facilitators transcribed the interview recordings verbatim and translated as needed (for those conducted in Yoruba). The recordings were saved in a password-protected computer accessible only to the authors and deleted off the digital recorders. The first author read the transcripts, integrated them with the facilitators' field notes, removed transcription errors from the data and edited where necessary to ensure consistency with the audio recordings. The health worker transcripts were returned to the participants for review and the minimal (mainly editorial), corrections made were effected after which the transcripts were de-identified. This member-check was to improve the credibility of the data by ensuring accuracy of the transcripts prior to coding and analysis (42). For the FGDs, the facilitators summarized responses as the discussions progressed to ensure the viewpoint expressed was understood and correctly captured. Thematic analysis using inductive coding was applied in analyzing the data (43, 44). To avoid bias and enhance trustworthiness in the analysis, two independent coders who are not authors on this paper read through a sample of the transcripts and developed codes inductively. A consensus meeting between the independent coders and the first author was held to discuss the codes and reach an agreement on code definitions and themes. The total of 15 codes identified were merged into four main themes and subthemes which the first author applied to the data and supportive quotes were identified for inclusion in the paper. The data analysis was done using MAXQDA 2018 (45). The preparation of this article was guided by the Consolidated Criteria for Reporting Qualitative Research (COREQ) (41).

Ethical considerations

The study was performed following the principles of the Declaration of Helsinki. Participants were provided with an information sheet detailing the study process and implications. Participation was voluntary with minimal risks; consent both for participation and recording of the interviews or discussions was obtained from all participants. No identifying data was collected, and the transcripts were saved in a password-protected computer accessible only to the authors. Ethical approval was received from the Oyo State Ministry of Health (Approval number AD/13/479/565), the University of Ibadan/University College Hospital (UI/UCH) Institution Review Board (UI/EC/17/0390), and the Wits Human Research Ethics Committee (Medical; Clearance number M171054).

Results

Sociodemographic information

There were 85 participants including men and women community members, community and religious leaders, and health workers (Table 1). All the potential participants who were approached agreed to participate in the study. The sociodemographic characteristics of the participants is shown in Table 2.

TABLE 2 Age and sex distribution of the study participants.

Sociodemographic characteristics		Frequency ($N = 85$)
Sex	Men	47
	Women	38
Age (years)	18–25	15
	26–35	11
	36–45	29
	≥ 46	30
Community members' distribution ($n = 45$)		
Marital status	Single	22
	Married	23
Educational status	Less than basic education	15
	Basic education and higher	30
Occupation	Trading	17
	Artisans	13
	Students	12
	Unemployed	3

Themes and subthemes

Four main themes were identified from the data as shown in Table 3. These themes are described in the following sections with supporting quotes.

The importance of male fertility

All the groups of participants believed that health care for men should include a focus on male infertility. The participants also stated that PCC may be an opportunity to address male infertility as highlighted in the two subthemes.

Health care for men should address infertility

At the community level, the concern for men's health was mainly about their role in the fertility equation with several participants describing the possibility of low sperm count and the need to address it. The health workers also spoke extensively about the need to address infertility in men because when couples have challenges with conception the usual impression is that the woman has a problem whereas the problem may be solved by addressing the man's health.

> Also, to buttress what they've been saying, men have to go for check-up too because there are some men that have low sperm count. I also think men should avoid certain food items that could cause low sperm count or that could hinder them from getting their wives pregnant.—**FGD Participant1; Single Women Less than Basic Education FGD**

> Also, the sperm cells of the man may not be fertile. This can be treated if it is detected during tests by the doctor.—**FGD Participant1; Married Women Basic Education and Above**

> It is also possible that the husband may have low sperm count and that may lead to infertility.—**FGD Participant1; Single Men Less than Basic Education**

PCC for men can address potential causes of infertility

Following up oengn the need for men's health care to address infertility, some of the health workers held the view that PCC for men may be an opportunity to address potential causes of infertility. They however stated that most men are unaware of their need for such care and do not present to the health facility for it. They went further to state that there are no programs targeted at men's health specifically within the Nigerian health care space.

> Yes, they need it please. The reason is that some diseases occur in childhood that can cause infertility in men and most of the time they will say the problem is with the woman.

TABLE 3 Themes derived from the data.

Themes	Subthemes/description
Why men's health requires attention	Participants' views on the need for specific attention being given to men's health. There were three subthemes: 1. Preventing transmission of infections 2. Providing support to partners 3. Potential impact on the health of future children
The importance of addressing male infertility	Participants' opinions about the importance of specific health care for men. There were two subthemes: 1. Health care for men should address infertility 2. PCC for men can address potential causes of infertility
How men receive or respond to health care	Description of the ways in which men present to health facilities for health care and their response to the service provided
Opinions about men's need for PCC	Participants' opinions about the need for PCC among men. There were three subthemes identified: 1. Men need PCC 2. Men need PCC, but women need it more 3. Men do not need PCC

So men too need to go to the hospital and check themselves, check their sperm counts.—**Public Health Nurse; Primary Care Level**

I believe men do though most of the time they do not present themselves or they are not aware they need such care too. I don't think they are really aware or maybe it's the Nigerian system. I don't think we have any program for men or young boys or any program to train them or prepare them for fatherhood.—**Public Health Nurse; Tertiary Care Level (ICH)**

Why men's health requires attention

The participants gave their opinions about the importance of specific health care for men including prevention of transmission of infections to partners, providing support to partners, and the potential impact of men's health on future children.

Preventing transmission of infection

Some of the participants believed that there is a need for specific health services for men to screen and provide treatments that would prevent the transmission of infection to their partners.

It is important for the man too to take care of himself before he sleeps with the woman and gets her pregnant and it is important that they go for check-up so that neither of them infects the other.—**Female Community Leader**

Providing support to partners

The supportive role of men to their partners was highlighted as another reason for paying attention to men's health. During visits to health facilities, information on women's health could be given to the men, enabling them to provide evidence-based care to their partners.

The youths, the husband and wife should both have preconception care in order to add to their knowledge so that they will know what to do per time. For example, they will be enlightened on the kind of food the wife must eat before and during pregnancy and the kind of work, she must do.—**FGD Participant1; Single Men Basic Education and Above**

Potential impact on the health of future children

The pediatric specialists provided reasons for men requiring health care, mainly concerning the effect of men's health on the overall health of their families. The potential impact of a man's health on his contribution to the genetic pool of his child was stated. Also highlighted was the key role of men as breadwinners for their families which may be impacted negatively by poor health.

Yes, the health of men of reproductive age is also important. Why is it important? This may sound a bit selfish but a man is typically the breadwinner in our setting. If he lives a short life that means the woman and the children are going to be in trouble. So, he has to be healthy so that he can take care of his wife financially and be the father figure for the children so they can be psychologically stable and secure.—**Pediatric Cardiologist; Tertiary Care Level**

Well, for example, psychological or mental health problems can affect the baby because the way the father views things and the decisions he takes can have negative or positive impact on the baby. Also, he will pass on some genes that will affect the baby.—**Pediatrician; Tertiary Care Level**

How men receive or respond to health care

The health workers described men as being reluctant to seek health care. They stated that in their experience men tend to be less open about their reproductive health needs until a problem arises that they are unable to handle. Adolescent men often request help from health workers when pubertal changes begin and they need reassurance. Older men are often not seen in the clinics until they have questions about fertility which usually arise when their wives are unable to attain conception at the desired time.

> … Men will not come out the way women will just come out and say this is what I'm feeling. You know men, they will just be perambulating and until you send them for some tests, then they will come and start to ask questions after getting their results. That is when you can counsel on the issues; either low or zero sperm count.—**Secondary Health Care Level Nurse**

> Mostly, you know men don't usually have problem and when they have, they don't own up on time but most of those we see are in the younger age group and that is where adolescent care comes in. During adolescence they start seeing changes in their bodies and are confused. Psychologically and emotionally you have to stabilize them and let them know that it's a normal phase. But for infertility in men, it usually comes up later in life and it is even the woman that presents first.—**Family Physician; Tertiary Care Level**

Opinions about men's need for PCC

The opinions about whether men require PCC or not varied among the study population. While some participants believed men need PCC and should receive it, others believed that men do not need PCC at all or as much as women do.

Men need PCC

Medical screening is necessary to prevent pregnancy complications

At the community level, participants were of the opinion that PCC should not just be for women. Highlighting the man's role in pregnancy outcomes, they stated that the medical tests recommended during the preconception period should include both men and women. The possibility of low sperm counts leading to infertility came up in many of the discussions and was described as potentially amenable to PCC. The importance of the blood group and genotype in the occurrence of birth complications and having babies with sickle cell disorder was also mentioned.

> The couple must have some medical tests done. These include genotype test, blood group, and HIV test in order to prevent complications arising after marriage. It should not

just be about women; men also need to be taken care of. In one of the programs that we just had, we found some men had health problems. Some had low sperm counts and did not know the cause until they visited the hospital. So, like has been said it is important for men to have medical check-ups too so that they will be in good health before pregnancy.—**FGD Participant4; Christian Clergy**

> If the man has an infection, the new-born child will be affected by whatever disease he has. And if the man is healthy and the woman has a disease, their child will also be affected by that disease, because one of the sources from which the child is coming already has a defect. So, the man needs to examine himself, and go for a check-up to determine if he is healthy enough to be a father.—**FGD Participant4; Muslim Clergy**

> From my perspective, it is important for both of them to know about preconception care when planning to get pregnant because both of them may belong to the blood group AS.— **FGD Participant1; Single Men Less than Basic Education**

> The man that wants to impregnate his wife should go for a blood test. Some issues with their blood group and genotype can cause complications or they can give birth to a child with sickle cell. But if they have gone through a series of medical tests, the doctor will know the kind of treatment to be given to them after they have identified if they have any disease.—**FGD Participant1; Married Women Basic Education and Above**

Men need PCC but women need it more

On the other hand, some the health workers expressed the opinion that although men require PCC, their reproductive health tends to be neglected in favor of women's health both socially and medically. This neglect of men's health in favor of women is believed to stem from the fact that women's health is believed to require more attention because they are the ones who become pregnant. From the cultural perspective, the expectations regarding fertility in society are often skewed more toward women than men.

> Men require care also but medically and also socially we tend to neglect the reproductive aspect of men's health unless they have problems with infertility and the like. However, I believe they also need preconception care.— **Ob/Gyn; Secondary Care Level**

> Men also need preconception care but not as much as women.—**Community Physician 1; Tertiary Care Level**

It is usually when men have problems that we attend to them specially because even in our culture we don't believe they have problems with conception, it's usually women. You know, even if there is infertility between husband and wife, and it is the husband who has the problem, it is always assumed first that it is the woman.— **Public Health Nurse; Tertiary Care Level (Community Medicine)**

Men do not need PCC

Some of the married men expressed the opinion that there is no need for men to have PCC. Men are expected to be healthy and care for their families and should not need special attention to their health, they opined.

*Well to my own understanding, we are the men of the house and if we are healthy, we should go out and look for what the family will eat. I have to go out because if I stay at home, there is nothing to eat. I don't think men need any special care.—*FGD Participant1; Married Men Less than Basic Education

Stating the assumption that men are generally healthy, some of the health workers were categorical in the expression of their belief that men do not need PCC. Some health workers stated that men would benefit from access to health care but not PCC while others were not aware of PCC services for men.

*Whether men need care that is different, I don't think they do except if there are special considerations.—*Community Physician 2; Tertiary Care Level

*They require care but not preconception care, just normal health care.—*Pediatrician; Secondary Care Level

*Interestingly, I am just hearing that for the first time. I have not heard about preconception care for men before. I didn't even know that services like that existed.—*Ob/Gyn; Secondary Care Level [Private]

*We see men of that age but we don't ask them if their wife is about to conceive; our aim for all patients really is to get optimal glucose control, blood pressure control, make sure they are optimally healthy at all times … maybe the urologists will be able to tell us better. But a normal man walking down the street I think they are healthy.—*Endocrinologist; Tertiary Care Level

Discussion

This qualitative exploration revealed different views about men's need for PCC among the study participants. Identifying the importance of men's genetic contribution to pregnancy outcomes and men's role within the family, participants stated the belief that there is a need to pay attention to men's health. They however described men as being hesitant to seek health care, which poses a challenge to them receiving the attention they require timeously. Speaking specifically about PCC, opinions were diverse with respect to its relevance to men's health. While some of the participants believed that PCC is important for men, some stated that PCC is more essential for women than men while others disagreed emphasizing that men have no need for PCC.

Most African communities place a high premium on childbearing and this is the case in Nigeria where the study was done. Childbearing is important regardless of gender and pregnancy is culturally expected soon after marriage, although women are often the focus of attention in this regard more than men [30]. The emphasis on low sperm counts and its impact on pregnancy desire is therefore logical in the context. Many of the participants viewed prevention and treatment of low sperm count and other potential causes of infertility as important reasons to address men's health. In addition, the importance of preventing transmission of infections to their partners and potentially transferring genetic diseases to their children was also highlighted. Research abounds on the genetic influences of men's environmental and lifestyle exposures and the impact of these on reproductive health outcomes [1, 7, 21–23]. In societies where childbearing has a high value, PCC is relevant to addressing factors that can potentially cause delay or prevent the attainment of fatherhood.

Some of the participants also described the important roles men play in supporting their partners through pregnancy and childbirth once they have the needed information. PCC can be an opportunity to provide health information to couples ahead of pregnancy. Extant literature has documented that apart from being beneficial to the men themselves, providing PCC for men increases the likelihood of their female partners adhering to the lifestyle changes needed for optimal preconception health [10]. For men who do not believe they need PCC, support for their partners' health can be a strategy to encourage them to access the service. Once in the system, they can then be provided with other services that will be beneficial for their health.

Similar to what is known for women, male fecundity and fertility can also be negatively impacted by risk factors such as stress, environmental toxins, excessive alcohol consumption, use of tobacco and other harmful substances, and obesity [7, 21–23]. Unlike the services available for women through maternal health care, however, men's health has not been similarly addressed. Although there is some evidence that men who are preparing

to be fathers may be concerned about their health, they may not be receiving adequate information about risk factors and critical issues because health care providers are not aware or trained to provide the service (10, 46). A study among Nigerian women with pre-existing medical conditions showed missed opportunities for PCC services despite regular contact with the health system on account of their past medical history (47). These factors, coupled with a lack of awareness among health care workers as described in this study may explain the reluctance with which men approach reproductive health services. To combat this reluctance, there is a need for improved awareness of the importance of men's overall and reproductive health among health care providers and at the community level.

Community and religious leaders are able to fill the gap in raising awareness about men's health at the community level. This is because besides exercising authority within their sphere of influence, the community members have implicit trust in them as sources of information and custodians of culture establishing and protecting traditional norms (48). Extant literature documents the importance role that community and religious leaders play as change agents and gatekeepers at the community level (49–51). Instances of this influence are largely related to maternal and child health, including family planning (49), prevention of HIV (48), protecting and improving child health, (51) among other health issues. An extension of their role to include men's health care is possible especially in communities where they provide premarital counseling. It is therefore important to involve community and religious leaders in the advocacy and awareness campaigns for men's health care including PCC.

The perception that PCC is more important for women than men has been documented previously where the participants stated that the term PCC appears to be targeted toward women because they are the ones who become pregnant (30, 52, 53). Participants in these studies opined that some health behaviors such as alcohol consumption and tobacco use were more relevant for men than women. They, therefore, believed PCC should be applicable directly to men and not only to women. In other studies, participants expressed the opinion that both men and women need to be involved in the pregnancy process right from the preconception period (17, 54). Similar perceptions could have influenced the different views expressed in the current study. Those who hold to the opinion that a more inclusive terminology is required are more likely to believe that there is a need for PCC services to be targeted at men compared with those whose opinion is that women require PCC in order to be prepared for pregnancy. Although PCC originally focused on women and the interventions provided addressed maternal health and access to health care, the benefits extended to neonatal, infant, and child health. The acknowledgment of the role of men's health has led to an expansion of PCC to include men's health (9). To improve uptake of PCC services among men, this understanding needs to be emphasized through training of health care providers and improved awareness within community settings.

This study is novel in its presentation of viewpoints about men's reproductive health needs with a focus on PCC. Although limited in terms of the context of the study, the perception among the health care providers, community members and community and religious leaders has not been documented previously. The viewpoints expressed may be therefore transferable to similar contexts within many LMICs. The also raises questions for further research into factors influencing men's healthcare seeking behavior which may be explored at community and health service level.

Conclusion

Although many of this study's participants identified the need to provide health services for men, reluctance to access health services among men was highlighted. This reluctance could be due to a lack of perception of need among men, especially with regard to PCC. The views proffered concerning men's need for PCC varied from an agreement that PCC is required to denial of the need for such services among men. This variation in opinion cut across the different participant groups highlighting the need for improved awareness about men's reproductive health needs both among health workers and at the community level. This variation speaks to the low level of attention given to men's reproductive health. In addition, the lack of inclusion of men's health in health policies and programs may explain some of the opinions expressed in this study. Since PCC service provision is still rudimentary in Nigeria, successful deployment and uptake will require inclusion of men's need for PCC in health-related policy updates, adequate training of health workers on PCC services and improved awareness at the community level. Future research may examine the possible role of community and religious leaders in encouraging men's uptake of reproductive health care and the acceptability of PCC services for men on a broader scale across other communities in sub-Saharan Africa.

Data availability statement

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

Ethics statement

The studies involving human participants were reviewed and approved by Oyo State Ministry of Health (Approval number AD/13/479/565), the University of Ibadan/University College Hospital (UI/UCH) Institution Review Board (UI/EC/17/0390), and the Wits Human Research Ethics Committee (Medical;

Clearance number M171054). The patients/participants provided their written informed consent to participate in this study.

Author contributions

OO and LI: study concept and design, analysis and interpretation of data, critical revision of the manuscript for important intellectual content, and final approval of the manuscript. OO: acquisition of data and drafting of the manuscript.

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Conflict of interest

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

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References

1. Toivonen KI, Oinonen KA, Duchene KM. Preconception health behaviours: a scoping review. *Prev Med.* (2017) 96:1–15. doi: 10.1016/j.ypmed.2016.11.022

2. Verbiest S, Shawe J, Steegers EAP. Advancing preconception health globally: a way forward. In: J Shawe, editor, *Preconception Health and Care: A Life Course Approach.* Cham: Springer Nature Switzerland AG (2020). p. 299–308. doi: 10.1007/978-3-030-31753-9_15

3. World Health Organization. *Meeting to Develop a Global Consensus on Preconception Care to Reduce Maternal and Childhood Mortality and Morbidity. WHO Headquarters, Geneva Meeting Report.* Geneva: World Health Organization (2012).

4. Omigbodun AO. Preconception care in Nigeria: prospects and constraints. *Archiv Ibadan Med Bookbuild.* (2002) 3:3–5. doi: 10.4314/aim.v3i1.34568

5. Frey KA, Navarro SM, Kotelchuck M, Lu MC. The clinical content of preconception care: preconception care for men. *Am J Obstet Gynecol.* (2008) 199:S389–95. doi: 10.1016/j.ajog.2008.10.024

6. Buck Louis GM, Barr DB, Kannan K, Chen Z, Kim S, Sundaram R. Paternal exposures to environmental chemicals and time-to-pregnancy: overview of results from the LIFE study. *Andrology.* (2016) 4:639–47. doi: 10.1111/andr.12171

7. Kothari A, Thayalan K, Dulhunty J, Callaway L. The forgotten father in obstetric medicine. *Obstet Med.* (2019) 12:57–65. doi: 10.1177/1753495X18823479

8. Atrash H, Jack BW, Johnson K. Preconception care: a 2008 update. *Curr Opin Obstet Gynecol.* (2008) 20:581–9. doi: 10.1097/GCO.0b013e328317a27c

9. Garfield CF. Toward better understanding of how fathers contribute to their offspring's health. *Pediatrics.* (2018) 141:e20173461. doi: 10.1542/peds.2017-3461

10. O'Brien AP, Hurley J, Linsley P, McNeil KA, Fletcher R, Aitken JR. Men's preconception health: a primary health-care viewpoint. *Am J Mens Health.* (2018) 12:1575–81. doi: 10.1177/1557988318776513

11. Choiriyyah I, Sonenstein FL, Astone NM, Pleck JH, Dariotis JK, Marcell AV. Men aged 15–44 in need of preconception care. *Matern Child Health J.* (2015) 19:2358–65. doi: 10.1007/s10995-015-1753-7

12. Abrha MW, Asresu TT, Weldearegay HG. Husband support rises women's awareness of preconception care in northern Ethiopia. *Scientific World J.* (2020) 2020:1–7. doi: 10.1155/2020/3415795

13. Casey FE, Sonenstein FL, Astone NM, Pleck JH, Dariotis JK, Marcell AV. Family planning and preconception health among men in their mid-30s developing indicators and describing need. *Am J Mens Health.* (2016) 10:59–67. doi: 10.1177/1557988314556670

14. Dean S V, Lassi ZS, Imam AM, Bhutta ZA. Preconception care: promoting reproductive planning. *Reprod Health.* (2014) 11:S2. doi: 10.1186/1742-4755-11-S3-S2

15. Coffey K, Shorten A. The challenge of preconception counseling: using reproductive life planning in primary care. *J Am Assoc Nurse Pract.* (2014) 26:255–62. doi: 10.1002/2327-6924.12054

16. Grace B, Shawe J, Johnson S, Stephenson J. You did not turn up… I did not realise I was invited…: understanding male attitudes towards engagement in fertility and reproductive health discussions. *Hum Reprod Open.* (2019) 2019:1–7. doi: 10.1093/hropen/hoz014

17. Poels M, Koster MPH, Franx A, van Stel HF. Parental perspectives on the awareness and delivery of preconception care. *BMC Pregnancy Childbirth.* (2017) 17:9–11. doi: 10.1186/s12884-017-1531-1

18. Hamm M, Evans M, Miller E, Browne M, Bell D, Borrero S. "It's her body": low-income men's perceptions of limited reproductive agency. *Contraception.* (2019) 99:111–7. doi: 10.1016/j.contraception.2018.10.005

19. Hammarberg K, Collins V, Holden C, Young K, McLachlan R. Men's knowledge, attitudes and behaviours relating to fertility. *Hum Reprod Update.* (2017) 23:458–80. doi: 10.1093/humupd/dmx005

20. Martín-Calvo N, Mínguez-Alarcón L, Gaskins AJ, Nassan FL, Williams PL, Souter I, et al. Paternal preconception folate intake in relation to gestational age at delivery and birthweight of newborns conceived through assisted reproduction. *Reprod Biomed.* (2019) 39:835–43. doi: 10.1016/j.rbmo.2019.07.005

21. Segal TR, Giudice LC. Before the beginning: environmental exposures and reproductive and obstetrical outcomes. *Fertil Steril.* (2019) 112:613–21. doi: 10.1016/j.fertnstert.2019.08.001

22. Braun JM, Messerlian C, Hauser R. Fathers matter: why it's time to consider the impact of paternal environmental exposures on children's health. *Curr Epidemiol Rep.* (2017) 4:46–55. doi: 10.1007/s40471-017-0098-8

23. Kotelchuck M, Lu M. Father's role in preconception health. *Matern Child Health J.* (2017) 21:2025–39. doi: 10.1007/s10995-017-2370-4

24. Stephenson J, Fleming TP, Yajnik CS, Prentice AM, Forrester T, Barker M, et al. Origins of lifetime health around the time of conception: causes and consequences. *Lancet.* (2018) 391:1842–52. doi: 10.1016/S0140-6736(18)30312-X

25. Stephenson J, Patel D, Barrett G, Howden B, Copas A, Ojukwu O, et al. How do women prepare for pregnancy? Preconception experiences of women attending antenatal services and views of health professionals. *PLoS ONE.* (2014) 9:103085. doi: 10.1371/journal.pone.0103085

26. National Population Commission, ICF. *Nigeria Demographic and Health Survey 2018*. Abuja; Rockville, MD (2019).

27. Sekoni OO, Ojifinni OO, Adediran OS. Spousal communication and family planning use among married adults in a rural community in Nigeria. *Nigerian J Public Health*. (2017) 2:139–50.

28. Smith DJ. Masculinity, money, and the postponement of parenthood in Nigeria. *Popul Dev Rev*. (2020) 46:101–20. doi: 10.1111/padr.12310

29. Ntoimo LFC, Isiugo-Abanihe U. Patriarchy and singlehood among women in Lagos, Nigeria. *J Fam Issues*. (2014) 35:1980–2008. doi: 10.1177/0192513X13511249

30. Ojifinni OO, Ibisomi L. Preconception care practices in Nigeria: a descriptive qualitative study. *Reprod Health*. (2020) 17:172. doi: 10.1186/s12978-020-01030-6

31. Adesina K, Aderibigbe S, Fawole A, Ijaiya M, Olarinoye A. Pregnancy outcome of the obese in Ilorin. *Obstet Med*. (2011) 4:160–3. doi: 10.1258/om.2011.100081

32. Creswell JW, Poth CN. *Qualitative Inquiry and Research Design: Choosing Among Five Approaches*. 4th ed. Thousand Oaks, CA: Sage Publications Inc. (2018).

33. Green J, Thorogood N. Qualitative methods for health research. 3rd ed. In: J Seaman, L Mehrbod, I Antcliff, K Harrison, editors, Thousand Oaks, CA: Sage Publications, Inc. (2014).

34. Heale R, Forbes D. Understanding triangulation in research. *Evid Based Nurs*. (2013) 16:98–98. doi: 10.1136/eb-2013-101494

35. Federal Ministry of Health Nigeria. *National Health Policy 2016: Promoting the Health of Nigerians to Accelerate Socioeconomic Development*. Abuja (2016).

36. National Primary Health Care Development Agency (NPHCDA). *Minimum Standards for Primary Health Care in Nigeria*. Abuja (2012).

37. Aigbiremolen AO, Alenoghena, Eboreime E, Abejegah C. Primary health care in Nigeria: from conceptualization to implementation. *J Medical Appl Biosci*. (2014) 6:35–43.

38. Wekesah F, Izugbara C. *Maternal Health in Nigeria: Facts and Figures. African Population and Health Research Centre Fact Sheet*. (2017). Available online at: http://aphrc.org/wp-content/uploads/2017/06/APHRC-2017-fact-sheet-Maternal-Health-in-Nigeria-Facts-and-Figures.pdf

39. Jayasekara RS. Focus groups in nursing research: methodological perspectives. *Nurs Outlook*. (2012) 60:411–6. doi: 10.1016/j.outlook.2012.02.001

40. Winke P. Using focus groups to investigate study abroad theories and practice. *System*. (2017) 71:73–83. doi: 10.1016/j.system.2017.09.018

41. Tong A, Sainsbury P, Craig J. Consolidated criteria for reporting qualitative research: a 32-item checklist for interviews and focus groups. *Int J Qual Health Care*. (2018) 19:349–57. doi: 10.1093/intqhc/mzm042

42. Goldblatt H, Karnieli-Miller O, Neumann M. Sharing qualitative research findings with participants: study experiences of methodological and ethical dilemmas. *Patient Educ Couns*. (2011) 82:389–95. doi: 10.1016/j.pec.2010.12.016

43. Fereday J, Muir-Cochrane E. Demonstrating rigor using thematic analysis: a hybrid approach of inductive and deductive coding and theme development. *Int J Qual Methods*. (2006) 5:80–92. doi: 10.1177/160940690600500107

44. Braun V, Clarke V. Using thematic analysis in psychology. *Qual Res Psychol*. (2006) 3:77–101. doi: 10.1191/1478088706qp063oa

45. VERBI Software. *MAXQDA. 2018*. Berlin: VERBI Software (2017).

46. Frey KA, Engle R, Noble B. Preconception healthcare: what do men know and believe? *J Mens Health*. (2012) 9:25–35. doi: 10.1016/j.jomh.2011.11.001

47. Ojifinni OO, Ibisomi L. Exploring the need for preconception care: the pregnancy experiences of women with pre-existing medical conditions in Ibadan, Nigeria. *Afr J Reprod Health*. (2021) 25:28–38. doi: 10.21203/rs.3.rs-18571/v1

48. Chimatiro CS, Hajison P, Muula AS. The role of community leaders on adolescent's HIV and sexual reproductive health and rights in Mulanje, Malawi. *Reprod Health*. (2020) 17:8. doi: 10.1186/s12978-020-00917-8

49. Adedini SA, Babalola S, Ibeawuchi C, Omotoso O, Akiode A, Odeku M. Role of religious leaders in promoting contraceptive use in Nigeria: evidence from the Nigerian urban reproductive health initiative. *Glob Health Sci Pract*. (2018) 6:500. doi: 10.9745/GHSP-D-18-00135

50. Fantaye AW, Okonofua F, Ntoimo L, Yaya S. A qualitative study of community elders' perceptions about the underutilization of formal maternal care and maternal death in rural Nigeria. *Reprod Health*. (2019) 16:5. doi: 10.1186/s12978-019-0831-5

51. Eyber C, Kachale B, Shields T, Ager A. The role and experience of local faith leaders in promoting child protection: a case study from Malawi. *Intervention*. (2018) 16:31. doi: 10.1097/WTF.0000000000000156

52. Ojifinni OO, Munyewende PO, Ibisomi L. Exploring the perception of and attitude towards preconception care service provision and utilisation in a South Western Nigerian community – a qualitative study. *Afri Popul Stud*. (2021) 35:S102. doi: 10.11564/35-1-1529

53. Tuomainen H, Cross-Bardell L, Bhoday M, Qureshi N, Kai J. Opportunities and challenges for enhancing preconception health in primary care: qualitative study with women from ethnically diverse communities. *BMJ Open*. (2013) 3:1–9. doi: 10.1136/bmjopen-2013-002977

54. Bayrami R, Latifnejad Roudsari R, Allahverdipour H, Javadnoori M, Esmaily H. Experiences of women regarding gaps in preconception care services in the Iranian reproductive health care system: a qualitative study. *Electron Physician*. (2016) 8:3279–88. doi: 10.19082/3279

Risky sexual behavior among people living with HIV/AIDS in Andabet district, Ethiopia: Using a model of unsafe sexual behavior

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Introduction: Human immunodeficiency virus (HIV) infection continues to be a major public health problem in Ethiopia. Previous studies have described risky sexual behavior and associated factors among HIV−positive people. These studies, however, did not use a model of unsafe sexual behavior that could address both subjective and objective factors of sexual activity, and there is no study that examines the distal aspects of risky sexual behavior among people living with HIV/AIDS in Ethiopia. Therefore, this study aimed to examine the risky sexual behavior among people living with HIV/AIDS using a model of unsafe sexual behavior.

Methods: An institutional-based study was conducted from March to April 2022. The sample size was determined by using Sloven's formula. In this study, both quantitative and qualitative methods were employed. Study participants were selected using systematic sampling method. An interviewer-administered questionnaire was used to collect the data. Descriptive statistics and correlation tests were computed to analyze the data. The qualitative data was analyzed thematically.

Results: This study included a total of 181 PLWHA clients. The average score for participants' perception regarding the facts of HIV/AIDS was 48.7% (95% CI: 38.9, 58.4). Three months prior to the study, 46.3% of study participants had engaged in at least one risky sexual activity (95% CI: 33.8, 65.4). The correlation model revealed a positive correlation between living in a rural area and risky sexual behavior (p-value = 0.001). Furthermore, a poor perception of HIV risks was associated with risky sexual behavior (p-value = 0.003). Economic issues, stigma and discrimination, and usage of substances were also identified as contributing factors to unsafe sexual activity in the qualitative data.

Conclusions: A high proportion of PLWHA clients had engaged in at least one risky sexual activity in the 3 months prior to the study. It is not enough to be on ART; additional educational interventions that shape the sexual behavior of PLWHA clients must be considered.

KEYWORDS

sexual practice, HIV/AIDS, unsafe sex, risky behavior, Ethiopia

Introduction

Human immunodeficiency virus (HIV) infection continued to be a major public health problem in Ethiopia (1, 2). The country was one of the fourth countries that reported the highest number of new HIV infected individuals in Africa (3), whereby 22,300 people were newly infected and 690,000 were living with HIV/ acquired immune deficiency syndrome (AIDS) at the end of 2018 (4). HIV/AIDS was responsible for an estimated 34% of all young adult death rates in Ethiopia, and 66.3% of all young adult deaths in urban Ethiopia between the ages of 15–49 (5, 6). The national prevalence of HIV infection in Ethiopia is 0.9% in 2016 (7).

Because of the expansion of antiretroviral therapy (ART) services, people living with HIV/AIDS (PLWHA) are now in better health. A large number of HIV-positive people take ART drugs, and the majority of them believe they are not at risk of transmitting the virus, leading them to engage in risky sexual activity (8). In fact, ART decreases patients' viral loads to undetectable levels, leading to the false impression that they are no longer infectious (9, 10). However, it is important to remember that risky sexual behavior puts people at risk for a range of sexual-related problems such as contracting STIs, unintended pregnancies, and septic abortions (3, 4, 8). Available studies reported that risky sexual practices expose PLWHA clients to new HIV strains resistant to antiretroviral therapy (ART) (5, 11). Accordingly, regardless of whether or not ART is used, adopting safer sex practices is critical for preventing HIV transmission in areas where a substantial number of individuals are living with HIV/AIDS such as Ethiopia (5, 12).

The previous studies have described risky sexual behavior and associated factors among people living with HIV/AIDS. These studies only describe having multiple partners, using condoms inconsistently, sharing needles and syringes to inject drugs, and disclosing status from partners as risky sexual behavior for PLWHA (7, 13, 14). Besides, these studies, however, did not use a model of unsafe sexual behavior that could address both subjective and objective factors of sexual activity.

To the best of our knowledge, there is no study that examines the distal aspects of risky sexual behavior such as societal norms and beliefs about HIV/AIDS, as well as the commoditization of sex as a source of money among people living with HIV/AIDS in Ethiopia. Therefore, this study aimed to examine the risky sexual behavior among people living with HIV/AIDS using a model of unsafe sexual behavior. This model could help better understand risky sexual practices precisely because the model incorporates three interactive components: personal factors, and proximal and distal contexts that best explain risky sexual practices, particularly in the context of HIV/AIDS.

Methods

Study design, setting and period

A mixed-method study that included both quantitative and qualitative data was conducted from March to April 2022 in 4 health facilities in Andabet district, Amhara regional state, Ethiopia. The district is located 710 kilometers away from Addis Ababa (capital city of Ethiopia) and 150 kilometers far from Bahir Dar city (the city of Amhara regional state). The district has an estimated total population of 145, 208. Of these, only 3.4% of the population lived in the urban area. Currently, a total of 296 clients registered and started ART in the four health facilities in the district.

Study population

The study participants were PLWHA who attended their ART in four health facilities; namely Andabet primary hospital, Andabet Health center and Jaragedu health center. The study comprised registered PLWHA clients. Those clients under the age of 18 and those who were seriously ill were excluded from the study.

Sample size and sampling techniques

The sample size for quantitative data was determined by using Sloven's formula because of its simplicity and the formula assumes a small population variance (15). The formula is given by ($n = \frac{N}{1+N(e)^2}$) where n is the sample size, N is the eligible population size ($N = 296$) and e is the margin of error (0.05). Adding a non-response rate of 10%, the total sample size of 188 participants was selected. Both quantitative and qualitative methods were employed. Study participants were selected using systematic sampling method. Additionally, twelve in-depth interviews (seven female and five male participants) were arranged based on the need of the study.

Measurements

Risky sexual behavior was assessed by using a model of unsafe sexual behavior. This model is the most commonly used model to explain risky sexual behaviors in the context of HIV/AIDS. It identifies three factors that influence sexual behavior: personal, proximal and distal context (16).

The personal factors (factors that affect risky sexual behaviors from within the person) include the participants' knowledge and perception of HIV risks. Knowledge questions in relation to facts about HIV/AIDS were: What are the ways of

HIV transmission? What are the preventive methods for HIV infection? Respondents answered either "Yes" or "No" from the listed options. Based on these questions, participants' knowledge of HIV/AIDS were calculated to classify the respondents into two groups. Respondents who scored the mean and above the mean score of correctly answered questions were classified as knowledgeable, and less than the mean score of correct answers were classified as not knowledgeable about facts in relation to HIV/AIDS.

The participants' perception of HIV/AIDS was assessed by 13 perception-related questions. The questions were three-point Likert-scale items (1 = Agree, 2 = Neutral, and 3 = Disagree). Respondents could answer either "agree", "neutral" or "disagree" from the listed options. Respondents who scored the mean and above the mean score of the correctly answered questions were classified as having a good perception of HIV risks.

Proximal factors (interpersonal relationships and social conditions) include access to HIV/AIDS information, access to free condoms, getting into forced sexual intercourse, having multiple sexual partners, disclosure of HIV status to a sexual partner(s), talking or introducing condoms during a sexual encounter, ever had sexual intercourse without a condom, and had sex after using substances (drinking alcohol and chewing chat). These variables were assessed by asking study participants about their experience of sexual activity in the 3 months prior to the study. Respondents could answer either "Yes" or "No" and "Yes" answers were considered as having risky sexual activity.

Distal factors include both cultural and structural factors. Cultural factors encompass societal norms and beliefs of the society toward sexual behavior. Structural factors comprise residency (comparison of urban and rural on sexual behavior), and economic status (such as poverty as commoditization of sex). Since these factors are relatively influenced by norms and beliefs of the local community, the variables were explored through an in-depth interview (qualitatively). The interview guide was: Why do PLWHA clients engage in risky sexual activity such as unprotected sex, and commercial sex?

To measure the overall risky sexual behavior of the respondents, the following two variables were used: having multiple sexual partners and inconsistent condom use within 3 months prior to the study. Both variables were measured by "Yes" and "No" questions, and if the respondent's answer was "Yes" for either of the above variables, then he or she was considered as having risky sexual behavior.

Data collection

An interviewer-administered questionnaire was used to collect the data. The questionnaire was pre-tested and designed first in English and then translated into Amharic (native language). The questionnaires were adapted from previous literature (17–19). Exit interviews were applied by trained enumerators. Five diploma nurses have participated in the data collection. Data completeness was checked by the investigators. For qualitative data, an open-ended guide was prepared to explore perceptions of sexual behavior.

The in-depth interviews were conducted in the local language until no new findings emerged. Study participants were given a subsequent code number based on their registration (respondent number). In addition to audio recording, written notes were taken from the depth interviews.

Data processing and analysis

The quantitative data were entered into SPSS version 21. Descriptive statistics were computed to explore the data. A correlation test was performed to analyze the data. And finally, the results of the quantitative data were presented in texts and tables with a p-value.

For qualitative data, the recorded data were transcribed verbatim in the Amharic language (national language). The typed narratives were then translated into English and verified for accuracy. No computer software was used for qualitative data analysis. The investigators read and reread the transcripts to be familiar with the data and a set of codes were developed to describe groups of categories with similar meanings. The grouped categories were refined and themes were generated from the text data manually. Direct quotations of participants' interviews were presented in italics to highlight key findings.

Ethical considerations

Ethical approval was obtained from the research and ethical review committee of Bahir Dar University. Written informed consent was obtained from each study participant. All the information obtained from participants was kept confidential throughout the process of study, and the name of the participant was replaced by a code. Withdrawal from the study at any point if they wished was assured.

Results

Socio-demographic characteristics of respondents

One hundred eighty-one PLWHA clients were interviewed, with a 96.3% response rate. The mean age of the respondents was 32.4(±3.8 SD) years. Females made up the majority of the respondents (66.3%), while 53.8% of the participants were married. The highest number of study participants (82.8%) were Orthodox Christians, and 63.6% of respondents had no formal

education. Nearly half of the respondents (47.4%) were farmers, while more than half (53.6%) were urban residents (Table 1).

Personal factors of risky sexual behavior

Participants' knowledge of HIV/AIDS

One hundred fifteen (63.6%) of study participants were aware of HIV transmission routes, while 79.4% were aware of HIV infection prevention measures. The most commonly reported HIV prevention method was consistent condom use during sexual intercourse (84.6%). On average, 71.3% of respondents were knowledgeable about HIV transmission and preventive measures (Table 2).

Participants' perception of HIV/AIDS

The respondents' perception of HIV/AIDS was computed by adding up the score of correct responses from thirteen statements. Accordingly, the average score for participants'

perception regarding the facts of HIV/AIDS was 48.7% (95%CI 38.9, 58.4) (Table 3).

Proximal aspects of risky sexual behavior

The proximal aspects of risky sexual behavior were reported by our study participants. As a result, 86.2% of those who participated in the survey had access to HIV/AIDS information. The majority of respondents (69.6%) were forced into sexual intercourse and 20.4% had multiple sexual partners. Nearly three-quarters (73.5%) of study participants talked about condoms during sexual encounters, but 19.3% had sex without a condom. On average, 46.3% of study participants had engaged in at least one risky sexual activity in the 3 months prior to the study (95% CI 33.8, 65.4) (Table 4).

TABLE 1 Sociodemographic characteristics of respondents in Andabet district, Ethiopia, 2022.

Socio-demographic characteristics	Categories	Frequency (%)
Age of respondents	≤25	39 (21.3)
	26–35	76 (42.2)
	36–45	56 (31.0)
	≥46	10 (5.5)
Sex	Male	61 (33.7)
	Female	120 (66.3)
Marital status	Married	97 (53.8)
	Unmarried	54 (29.8)
	Divorced/widowed	30 (16.4)
Religion	Orthodox	150 (82.8)
	Muslim	23 (12.6)
	Protestant	8 (4.6)
Educational status	No education	115 (63.6)
	Primary	51 (28.2)
	Secondary	8 (4.6)
	College and above	7 (3.6)
Occupational status	Employed	15 (8.3)
	Unemployed	48 (26.5)
	Farmer	86 (47.4)
	Others (Daily laborer)	32 (17.6)
Place of residency	Urban	97 (53.6)
	Rural	84 (46.4)
Lifetime sexual partner	One partner	142 (78.5)
	More than one partner	39 (21.5)

TABLE 2 The respondents' knowledge of HIV/AIDS in Andabet district, Ethiopia, 2022.

Variables	Categories	
What are the ways of HIV transmission?	Yes, N (%)	No, N (%)
Through unsafe sexual intercourse	159 (87.7)	22 (12.3)
Sharing needles and syringes	148 (82.1)	33 (17.9)
Blood transfusion	133 (73.4)	48 (26.6)
During pregnancy and childbirth	125 (69.2)	56 (30.8)
Through mosquito and another insect bite	84 (46.3)	97 (53.7)
Casual contact with a person (handshaking…)	41 (22.7)	140 (77.3)
Average knowledge of HIV transmissions	**115 (63.6)**	**66 (35.6)**
What are the preventive methods for HIV infection?	Yes, N (%)	No, N (%)
Abstain from sexual intercourse	152 (83.9)	29 (16.1)
Consistent use of a condom during sexual intercourse	153 (84.6)	28 (15.4)
Remain faithful to a partner	133 (73.5)	48 (26.5)
Avoid contaminated sharp objects	143 (78.9)	38 (21.1)
Avoid sex with sex workers	138 (76.2)	43 (23.8)
Average knowledge of preventive methods for HIV	**144 (79.4%)**	**37 (20.6)**
Overall knowledge of HIV risks	**Knowledgeable**	**Not knowledgeable**
	129 (71.3)	52 (28.7%)

TABLE 3   The respondents' perception of HIV/AIDS in Andabet district, Ethiopia, 2022.

Variables	Agree	Neutral	Disagree
Do you think a person can get HIV the first time he/she has sex?	47 (26.0)	12 (6.6)	122 (67.4)
My HIV status is personal and I will not disclose it to my sexual partner.	48 (26.3)	13 (7.4)	121 (66.3)
I have multiple sex partners because I am already positive and have nothing to fear.	37 (20.4)	15 (8.3)	129 (71.3)
Do you think premarital sex for youths is not supported?	148 (81.8)	10 (5.5)	23 (12.7)
Do you think that disclosing HIV status to a sexual partner affects the relationships?	65 (35.9)	12 (6.6)	104 (57.5)
Do you think that using condoms prevents other types of HIV infection if both sexual partners are HIV-positive?	33 (18.2)	29 (16.1)	119 (65.7)
Do you think that using condoms correctly and consistently reduces the risk of HIV transmission?	129 (71.3)	8 (4.7)	43 (24.0)
Do you think that using a condom is a sign of not trusting a sexual partner?	67 (36.8)	12 (7.0)	102 (56.1)
My sex partner dislikes using a condom during sexual intercourse.	88 (48.5)	42 (23.4)	51 (28.1)
Do you think that someone who has multiple sex partners has a high risk of contracting HIV?	162 (89.5)	2 (1.2)	17 (9.4)
Do you think that an HIV-positive person who begins ART will be cured of the virus?	48 (26.3)	4 (2.3)	129 (71.3)
Do you think that an HIV-infected person can live longer if she or he took ART?	174 (96.1)	3 (1.6)	4 (2.3)
Do you think that after starting ART, an HIV-positive person's need for sexual intercourse will increase?	102 (56.1)	36 (19.9)	43 (24.0)
Mean score of perception toward HIV/AIDS	**81 (48.7)**	**15 (8.2)**	**85 (43.1)**

TABLE 4   Risky sexual practices of respondents in Andabet district, Ethiopia, 2022.

Variables	Yes, N (%)	No, N (%)
Do you have access to HIV/AIDS information in your community?	156 (86.2)	25 (13.8)
Have you ever been forced into sexual intercourse?	126 (69.6)	55 (30.4)
Do you have multiple sexual partners?	37 (20.4)	144 (79.6)
Have you ever disclosed your HIV status to your sexual partner before having sex?	133 (73.5)	48 (26.5)
Do you have access to free condoms in your community?	32 (17.7)	149 (82.3)
Do you talk about or introduce condoms during sexual encounters?	133 (73.5)	48 (26.5)
Have you ever had sexual intercourse without a condom?	37 (19.3)	146 (80.7)
Have you ever did sex while you had drunk alcohol?	49 (27.1)	132 (72.9)
Have you ever did sex while you had chewed chat?	44 (24.3)	137 (75.7)
Average risky sexual practices	**84 (46.3)**	**97 (53.7)**

Distal aspects of risky sexual behavior

Distal aspects of risky sexual behavior include societal norms and beliefs about HIV/AIDS, as well as the commoditization of sex as a source of money. We used in-depth interviews to explore the data because these factors are influenced by the norms and beliefs of the local community. Study participants were interviewed individually. The interview questions were: Why do PLWHA clients engage in risky sexual activity such as unprotected sex, and commercial sex? Three themes have emerged from the data: Economic issues, the presence of stigma and discrimination and the use of substances. All of the reported findings are taken inductively from participants' responses and described below with quotations for each theme.

Theme one: Economic issues

The majority of young female PLWHA clients in the study area did not have a reliable source of income to lead their life properly, and they intentionally engaged in commercial sex to get money. For example, an interviewee (R6) said that:

"Sometimes, I have had sexual intercourse to get money. Because I did not have any other way to support myself, and I could not say no to sex if a man was willing to pay for it. For example, I know that my close girlfriend also has sex with many men in order to gain money, she does not have any other source of income other than this…"

Another interviewee (R4) also said that:

"I have a child whose father no longer lives with me. I have sexual relationships with other men, just to get income. To make money, I have been doing commercial sex to …".

Theme two: The presence of stigma and discrimination

The study participants also highlighted how stigma and discrimination contribute to unsafe sexual behavior. When there is high stigma and discrimination in the community about being HIV-positive, PLWHA clients tend to exclude themselves

from the community and even fear taking free condoms from the community and even fear taking free condoms from health facilities. In this regard, an interviewee (R7) reported that;

> "I wanted to get a condom from the health clinic, but I was afraid that others would know I was HIV positive, so I did not get a condom and had intercourse without it…He added… I understand that unprotected intercourse is a dangerous sexual behavior that might lead to HIV transmission".

Theme three: Use of substances (drinking alcohol, chewing chat)

The power of substances to stimulate the person to undertake unsafe sex was well explained by our study participants. One participant (R3) stated that:

> "Drinking alcohol motivates people to have sexual intercourse with HIV-positive people or healthy people. He could then become infected or spread HIV to others... Chewing chat has the same effect... stimulate to engage in unsafe sex".

Our interviewees also pointed out how using substances such as drinking alcohol and chewing chat could push risky sexual practices. An interviewee (R9) said that:

> "In our area, chat chewing is not as common as drinking alcohol. HIV-positive people have engaged in unsafe sexual intercourse with many people after they drink alcohol. This could then spread HIV to others...

Factors associated with risky sexual behavior

A correlation test was performed between risky sexual behavior and sociodemographic variables. The correlation model revealed a positive correlation between living in a rural area and risky sexual behavior (p-value = 0.001). Furthermore, a poor perception of HIV risks was associated with risky sexual behavior (p-value = 0.003) (Table 5).

Discussion

Personality factors play an important role in determining a person's sexual behavior (11, 20). Previous studies, for example, have revealed that people's knowledge and perceptions of HIV/AIDS facts influence risky sexual behavior among PLWHA clients. In this study, on average, 71.3% of respondents were knowledgeable about HIV transmission and preventive methods, whereas participants' perceptions of HIV risks were 48.7%. Previous studies have reported that PLWHA clients have a poor perception of HIV risks, which is consistent with our findings (21, 22). This finding adds to the growing body of evidence that HIV-positive clients who start ART tend to have a poor perception of HIV risks.

Even though 78.5% of respondents had talked about condoms with their partners, only 19.3% of them had sex without a condom. This suggests that there are significant gaps in the practice of safe sexual conduct among PLWHA that needs practical intervention. On average, 46.3% of study participants had engaged in at least one risky sexual activity within the 3 months prior to the study. Relatively, similar figures were reported from Addis Ababa (39.1%) (8), western Oromia (56.9%) (4) and Kembata Tembaro zone (40.9%) (23). It is, however, lower than reports from Gambella town (79.8%) (19). This discrepancy could be attributable to differences in study settings and measurements and definitions of risky sexual behavior among studies. Regardless of these variations, behavioral interventions that can reduce unsafe sexual practices among PLWHA should be emphasized.

In this study, societal norms and beliefs about HIV/AIDS, as well as the commoditization of sex as a source of money were explored through in-depth interviews as data triangulation is the best method to generate valid and more comprehensive findings. Economic concerns, stigma and discrimination, and substance abuse were the three themes that emerged from the study. Accordingly, our study participants lacked a stable source of income and engaged in commercial sex, which is a known risk factor for contracting a new strain of HIV (21).

Our study participants also mentioned that stigma and discrimination as contributing factors to unsafe sexual activity.

TABLE 5 Correlation test between risky sexual behavior and sociodemographic variables, 2022.

Variables		Risky sexual behavior		Pearson correlation coefficient	P-value
		Yes	No		
Sex of respondents	Male	37	24	0.209	0.070
	Female	85	35	1	
Place of residency	Urban	65	32	0.701	0.001
	Rural	57	27	1	
Perception of HIV risks	Poor	69	36	0.630	0.033
	Good	53	23	1	

In agreement with our study, previous studies have reported that perceived stigma and discrimination influence HIV/AIDS clients' ability to receive effective treatment (24). If there is a high stigma and discrimination toward HIV-positive status in the community, PLWHA clients tend to exclude themselves from the community and even fear taking free condoms from health facilities (25, 26). In addition to economic issues and the presence of stigma and discrimination, use of substance use of substances has the power to stimulate the person to undertake actions like unsafe sex (27). In this regard, our interviewees' pointed out how using substances such as drinking alcohol and chewing chat could push risky sexual practices. There is also evidence that heavy alcohol consumption can be linked to unprotected sex (14, 28). This means that being on ART is not enough; extra educational interventions that shape PLWHA clients' sexual behavior must be considered.

In this study, a correlation test was performed to see the association between risky sexual behavior and sociodemographic variables. The correlation model revealed a positive correlation between living in a rural area and risky sexual behavior. Moreover, a poor perception of HIV risks was associated with unsafe sexual conduct. A similar report was obtained in research conducted in Ghana (29), Nigeria (30) and Southern Ethiopia (21).

Limitations of the study

This study has some limitations that must be acknowledged. Quantitative results from a small sample size may be less reliable. Since there is no standardized definition of risky sexual behavior, the results of this study should be interpreted cautiously. The authors also have limitations associated with individuals' socially desired responses rather than true feelings.

Conclusions

High proportions of PLWHA clients had engaged in at least one risky sexual activity in the three months prior to the study. It is not enough to be on ART; additional educational interventions that shape the sexual behavior of PLWHA clients must be considered.

Data availability statement

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

Ethics statement

The studies involving human participants were reviewed and approved by the Research and Ethical Review Committee of Bahir Dar University. The patients/participants provided their written informed consent to participate in this study.

Author contributions

Acknowledgments

Conflict of interest

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

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References

1. Mosisa G, Woldemichael K, Ayalew F. Risky sexual behaviour and associated factors among antiretroviral therapy attendees in Nekemte Referral Hospital, Western Ethiopia: a cross-sectional study. *HIV AIDS.* (2018) 10:125–31. doi: 10.2147/HIV.S159670

2. Menna T, Ali A, Worku A. Prevalence of HIV/AIDS-related parental death and its association with the sexual behaviour of secondary school youth in Addis Ababa, Ethiopia: a cross-sectional study. *BMC Public Health.* (2014) 14:1–8. doi: 10.1186/1471-2458-14-1120

3. Gemechu AG, Assefa Ayana L, Waqtole ZD, Tola EK, Beyene MD. Risky sexual behaviour and its associated factors among daily labourers in Arjo-Didessa sugar factory, Jimma Arjo, Southwest Ethiopia: institution-based cross-sectional study. *SAGE Open Med.* (2021) 9:1–11. doi: 10.1177/2050312121994358

4. Balis B. Risky sexual practice and associated factors among women living with HIV/AIDS receiving antiretroviral therapy at a PMTCT clinic in Western Oromia, Ethiopia. *HIV AIDS.* (2020) 12:739–47. doi: 10.2147/HIV.S258740

5. Demissie K, Shifera Asfaw LA, Kiros G. Sexual behaviours and associated factors among antiretroviral treatment attendees in Ethiopia. *HIV AIDS.* (2015) 7:183–90. doi: 10.2147/HIV.S78300

6. Erena AN, Shen G, Lei P. Factors affecting HIV counselling and testing among Ethiopian women aged 15–49. *BMC Infect Dis.* (2019) 19:1–2. doi: 10.1186/s12879-019-4701-0

7. Alem AZ, Teshale AB, Liyew AM, Tesema GA, Tesema AK, Yeshaw Y. Determinants of HIV voluntary counselling and testing: multilevel modelling of the Ethiopian Demographic and Health Survey. *BMC Womens Health.* (2022) 22:1. doi: 10.1186/s12905-021-01590-0

8. Nuzzo JB, Meyer D, Snyder M, Ravi SJ, Lapascu A, Souleles J, et al. What makes health systems resilient against infectious disease outbreaks and natural hazards? Results from a scoping review. *BMC Public Health.* (2019) 19:1–9. doi: 10.1186/s12889-019-7707-z

9. Woldeyohannes D, Asmamaw Y, Sisay S, Hailesselassie W, Birmeta K, Tekeste Z. Risky HIV sexual behaviour and utilization of voluntary counselling and HIV testing and associated factors among undergraduate students in Addis Ababa, Ethiopia. *BMC Public Health.* (2017) 17:1–0. doi: 10.1186/s12889-017-4060-y

10. Cherie A, Berhane Y. Peer pressure is the prime driver of risky sexual behaviours among school adolescents in Addis Ababa, Ethiopia. *World J AIDS.* (2012) 2:159. doi: 10.4236/wja.2012.23021

11. Moges NA, Adesina OA, Okunlola MA, Berhane Y, Akinyemi JO. Risky sexual practice, sexually transmitted infection and associated factors among newly diagnosed HIV-positive people in Northwest Ethiopia. *HIV AIDS.* (2020) 12:431–9. doi: 10.2147/HIV.S267215

12. Hareru HE, Kaso AW, Ashuro Z, Mareg M. Risky sexual practice and associated factors among people living with HIV/AIDS receiving antiretroviral therapy in Ethiopia: systematic review and meta-analysis. *PLoS ONE.* (2022) 17:e0266884. doi: 10.1371/journal.pone.0266884

13. Ofurum IC. Sexual behaviour, needs and concerns regarding sexual and reproductive health among adults living with HIV in Sub-Saharan Africa: a systematic review. *J Adv Med Med Res.* (2021) 2021:113–32. doi: 10.9734/jammr/2021/v33i1130931

14. Engedashet E, Worku A, Tesfaye G. Unprotected sexual practice and associated factors among people living with HIV at Antiretroviral therapy clinics in Debrezeit town, Ethiopia: a cross-sectional study. *Reprod Health.* (2014) 11:1–9. doi: 10.1186/1742-4755-11-56

15. Tejada JJ, Punzalan JR. On the misuse of Slovin's formula. *Philipp Stat.* (2012) 61:129–36. Available online at: https://www.psai.ph/docs/publications/tps/tps_2012_61_1_9.pdf

16. Eaton L, Flisher AJ, Aaron LE. Unsafe sexual behaviour in South African youth. *Soc Sci Med.* (2003) 56:149–65. doi: 10.1016/S0277-9536(02)00017-5

17. Erku TA, Megabiaw B, Wubshet M. Predictors of HIV status disclosure to sexual partners among people living with HIV/AIDS in Ethiopia. *Pan Afr Med J.* (2012) 13:87. doi: 10.11604/pamj.2012.13.87.1476

18. Yalew E, Zegeye DT, Meseret S. Patterns of condom use and associated factors among adult HIV positive clients in North-Western Ethiopia: a comparative cross-sectional study. *BMC Public Health.* (2012) 12:1–6. doi: 10.1186/1471-2458-12-308

19. Wondemagegn F, Berkessa T. High level risky sexual behaviour among persons living with HIV in the urban setting of the highest HIV prevalent areas in Ethiopia: implications for interventions. *PLoS ONE.* (2020) 15:e0242701. doi: 10.1371/journal.pone.0242701

20. Berhan Y, Berhan A. A meta-analysis of risky sexual behaviour among male youth in developing countries. *AIDS Res Treat.* (2015) 2015:580961. doi: 10.1155/2015/580961

21. Tesfaye B, Seifu Y, Tekleselassie B, Ejeso A. The magnitude and associated factors of consistent condom utilization among ART users in Hawassa City, Sidama, Ethiopia. *HIV AIDS.* (2020) 12:909. doi: 10.2147/HIV.S280143

22. Kefale B, Kefale Y. Knowledge, attitude, practice and determinants of condom use among people living with HIV/AIDS in Gondar University Hospital, North West Ethiopia. *J Phys Pharm Adv.* (2013) 3:247–60. doi: 10.5455/jppa.20130915065207

23. Anore DL, Mengistie B, Geltore TE. Unprotected sexual practices and associated factors among adult people living with HIV on antiretroviral therapy in public hospitals of Kembata Tembaro Zone, Southern Ethiopia. *Pan Afr Med J.* (2021) 38:1–10. doi: 10.11604/pamj.2021.38.176.26105

24. Turi E, Simegnew D, Fekadu G, Tolossa T, Desalegn M, Bayisa L, et al. High perceived stigma among people living with HIV/AIDS in a resource-limited setting in Western Ethiopia: the effect of depression and low social support. *HIV AIDS.* (2021) 13:389–97. doi: 10.2147/HIV.S295110

25. Feyissa GT, Abebe L, Girma E, Woldie M. Stigma and discrimination against people living with HIV by healthcare providers, Southwest Ethiopia. *BMC Public Health.* (2012) 12:1–2. doi: 10.1186/1471-2458-12-522

26. Asgary R, Amin S, Grigoryan Z, Naderi R, Aronson J. Perceived stigma and discrimination towards people living with HIV and AIDS in Addis Ababa, Ethiopia: a qualitative approach. *J Public Health.* (2013) 21:155–62. doi: 10.1007/s10389-012-0533-8

27. Ritchwood TD, Ford H, DeCoster J, Sutton M, Lochman JE. Risky sexual behaviour and substance use among adolescents: a meta-analysis. *Child Youth Serv Rev.* (2015) 52:74–88. doi: 10.1016/j.childyouth.2015.03.005

28. Alamrew Z, Bedimo M, Azage M. Risky sexual practices and associated factors for HIV/AIDS infection among private college students in Bahir Dar City, Northwest Ethiopia. *Int Sch Res Notices.* (2013). doi: 10.1155/2013/763051

29. Agyeman-Duah E, Sampene PO, Fenteng EA, Ayibor W. Socio-demographic characteristics of people living with HIV/AIDS at KomfoAnokye teaching hospital, Ghana: a five-year retrospective study. *Acta Sci Med Sci.* (2018) 2:42–7.

30. Olley BO, Adebayo KO, Ogunde MJ, Odeigah W. Sexual activity and unprotected sex among treatment-seeking HIV/AIDS patients: a multi-site study in Nigeria. *Int J AIDS Res.* (2016) 3:54–8. doi: 10.19070/2379-1586-1600014

Frontiers in Public Health

Primary medical and health preparedness and people's life satisfaction in China: The mediating role of satisfaction with medical and health services

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Objective: To examine the association between primary medical and health preparedness (PMHP), satisfaction with medical and health services (SMHS), and life satisfaction (LS).

Methods: Using the latest national representative data from the 2019 Chinese Social Survey and the 2018 Health Statistics Yearbook for each province in China, we conducted multi-level models to test the effect of three aspects of PMHP (the number of primary medical and health institutions (PMHIs), the number of beds in PMHIs, and the number of staff in PMHIs) on LS, and the mediation role of SMHS in this effect.

Results: The number of staff in PMHIs has a significant positive effect on people's LS. Besides, this effect is mediated completely by SMHS. However, the number of PMHIs and the number of beds in PMHIs do not affect LS significantly.

Conclusions: PMHP has a positive impact on LS, but this impact is associated only with the number of staff in PMHIs. Therefore, governments should focus on optimizing human resources in PMHIs to meet the LS needs of individuals.

1. Introduction

Life satisfaction (LS) refers to the general cognition and evaluation of an individual's satisfaction with their quality of life (1). Individuals with a higher level of LS always exhibit better life outcomes, such as health (2), psychological wellbeing (3), social adjustment (4), and working performance (5), and thus LS is deemed to be an important indicator of the progress of individuals and society in general (6). Therefore, governments around the world regard improving people's LS as one of the core goals of public policies (7, 8). In China, the government has implemented a series of people-centered initiatives in the areas of pensions, employment, health, and social assistance (9, 10). However, reports have shown fluctuations in the LS of Chinese people (11), with a downward trend observed (12). This suggests that these initiatives may not necessarily have a positive association on LS. Therefore, it is critical to understand the effects of people-centered initiatives on LS to provide a reference that can be used to guide the government in devising effective strategies to improve LS.

Since people-centered initiatives are large, macroscopic projects, it is vital that the effects of these initiatives on LS are explored from this perspective. However, previous studies focus mainly on macro-inf   g factors such as air quality (13), government spending (14), social

justice (15), and urban density (16). As very important people-centered initiatives, medical and health services are major welfare projects provided by governments to improve the level of people's wellbeing (17, 18). Although these services play an important role in health promotion and quality of life, research on the effect of medical and health services on LS has mostly been conducted based on individual's perception (19, 20), while macro-level factors remain a relatively unexplored area.

Limited macro-level studies have mainly studied the impact of medical and health services on LS from an economic perspective. They found that people living in cities with higher health expenditure exhibited better LS (7, 8, 18, 21), namely, increasing expenditures in public health care has a positive effect on citizens' LS. This is because that public health investment can be regarded as a form of social insurance (7), which helps to meet people's medical needs, increase their sense of security and reduce their anxiety related to health problems (8). Moreover, a small number of studies have also explored the impact of medical service characteristics on LS, and found that higher number of health care facilities, better resident-to-employee ratio, and more staff in administration were positive associated with LS (22, 23). Although these studies have made valuable findings, they usually do not consider the heterogeneity of the level of medical institutions in their studies. As a result, it may be difficult to guide the formulation of more precise practical strategies, for example, which level of medical institutions should be invested more.

In China, the institutions providing medical and health services are categorized into three levels (24): level 1 hospitals are primary medical and health institutions (PMHIs), which aim to provide disease prevention and treatment, health promotion, and rehabilitation services to residents in the areas where the institutions are located (25); level 2 hospitals are regional hospitals that provide comprehensive medical and health services to multiple communities and undertake certain teaching and scientific research tasks; level 3 hospitals are regional or national hospitals that provide high-level specialized medical and health services to several regions and performs high-level teaching and scientific research (26, 27). Of these, PMHIs form the foundation of China's medical and health service system and play the role of gatekeeper for people's health. Efficient functioning of PMHIs is considered to be the foundation for achieving the Healthy China strategy. Accordingly, this study aims to explore the effect of primary medical and health preparedness (PMHP), which refers to the preparedness level of PMHIs, on people's LS, and thereby provide implication for policy planners and health care administrators to improve primary medical and health services.

In recent years, and especially after the promulgation of the new medical reform policy in 2009, the Chinese government has attached great importance to the construction of primary medical and health services, and the level of PMHP has been improved significantly. Indeed, the government hopes to address the long-standing problem of "expensive and inaccessible medical services in China," which has greatly reduced people's LS, by improving the current PMHP level (19). However, we do not know whether an increase in PMHP really improve LS? Therefore, this study will examine the effect of PMHP on LS. To this end, PMHP was evaluated in terms of three aspects in the current study: (1) the number of PMHIs, (2) the number of facilities (i.e., beds) in PMHIs, and (3) the number of staff in PMHIs. This type of measurement can comprehensively reflect the human and financial investment in PMHIs, thus contributing to the continuous quality improvement of delivering health care services. According to previous studies (22, 23), we expect the government's investment in primary health care preparation to be effective in improving LS, and thus assume that people living in areas with higher levels of PMHP show higher levels of LS (**H1**). Moreover, if PMHP positively affect LS, how does this effect work? As we all know, satisfaction with medical and health services (SMHS) is an important indicator of the quality of medical and health services (28, 29) and the basis for the stability of health systems (30). On one hand, SMHS is affected by PMHP. For example, the improvement of PMHP means an increase in the number of staff in PMHIs, while the adequate number of medical personnel was positively correlated with SMHS (31). One the other hand, prior studies have demonstrated that people with higher level of SMHS exhibited better LS (19, 20, 32). Therefore, it can be inferred that SMHS may play a mediation role in the relationship between PMHP and LS. Herein, we hypothesize that the effect of PMHP on LS is mediated by satisfaction with medical and health services (**H2**). This study examined the above hypotheses by matching individual-level data on self-reports of LS and SMHS by respondents of the 2019 Chinese Social Survey (CSS), with provincial-level data on PMHP from the 2018 Health Statistics Yearbook (HSY).

2. Methods

2.1. Data

The data used in this study were obtained from the 2019 CSS, and the 2018 HSY for each province in China. First, the CSS is a large nationwide survey project launched in 2005 by Institute of Sociology, Chinese Academy of Social Sciences to understand social changes in China (33). The survey was conducted every 2 years. Using a stratified random probability sampling method, the 2019 CSS investigated 10,283 families from 596 villages/communities in 149 counties of 30 provinces of China. The inclusion criteria for eligible participants were aged 18–69 years. The 2019 CSS contained modules for the retrieval of basic information, details of living conditions, social security, and social values as well as social evaluation. The data is publicly available on the CSS official website (http://css.cssn.cn/css_sy/). Considering that the 2019 CSS surveyed respondents' information in 2018, we used the 2018 HSY to obtain data related to PMHP in China. We then combined the data from the 2019 CSS and the 2018 HSY for statistical analysis.

2.2. Measurements

2.2.1. Life satisfaction

The question "how satisfied are you with the following items?" was used to measure LS. This question was followed by questions to survey the following six items: education level, leisure/entertainment/cultural activities, social life, family relationship, family economic status, and general LS. The answers for each item ranged from 1 to 10, representing "extremely unsatisfied (score = 1)" to "extremely satisfied (score = 10)." The sum of the scores of the first five items was calculated to evaluate LS with higher scores indicating a higher level of LS. In this study, the Cronbach's alpha for LS was 0.746. Moreover, the score of the last item (i.e., general LS) was used to conduct robustness analysis.

2.2.2. Primary medical and health preparedness

To objectively reflect the PMHP level of each province, we divided the data of each province on the three aspects of PMHP (i.e., the number of PMHIs, the number of beds in PMHIs, and the number of staff in PMHIs) by the population of each province to obtain the number of three aspects per 10,000 people at the provincial level. A province with a higher number per 10,000 people indicates that it has a higher level of PMHP.

2.2.3. Satisfaction with medical and health services

The question "how do you think of the medical and health services provided by governments?" was used to evaluate the level of SMHS. The response options included "very bad (score = 1)," "not good (score = 2)," "good (score = 3)," "very good (score = 4)," and "unclear." In this study, the "unclear" option was regarded as a missing value.

2.2.4. Satisfaction with medical security

Satisfaction with medical security (SMS) was used as the proxy variable of SMHS for robustness analysis. SMS was evaluated by the question "how satisfied are you with the medical security provided by governments?" with 11 response options ranging from "extremely unsatisfied (score = 1)" to "extremely satisfied (score = 10)," and one "unclear" option. The "unclear" option in this study was regarded as a missing value.

2.2.5. Social demographics

The following social demographic information was retrieved for each participant: sex (female = 0, male = 1), age, marital status, education level, economic status, and religious belief (or not); these characteristics were used as control variables (8, 34–36). Age was used as a continuous variable. Marital status was recorded as five categories: "unmarried," "married," "divorced," "widowed," and "cohabiting." Education level was considered as a continuous variable categorized as "illiterate (score = 1)," "primary (score = 2)," "middle (score = 3)," "high school or equivalent (score = 4)," "college (score = 5)," "bachelor's degree (score = 6)," and "master's degree or above (score = 7)." Economic status was evaluated by the question "what do you think of your social-economic status in the local area?" with the following response options: "low (score = 1)," "lower medium (score = 2)," "medium (score = 3)," "upper medium (score = 4)," "high (score = 5)," and "hard to say," which was coded as a missing value. Whether a respondent had a religious belief was recoded as a dummy variable, with having a religious belief coded as 1, and 0 otherwise.

2.3. Statistical analysis

First, the frequency (percentage) or mean (standard deviation) of variables was reported. We then mapped the provincial distribution of PMHP levels. Next, we used a multi-level (two-level) model for statistical analysis since our data included individual level and provincial level data. We estimated the effect of PMHP (X) on LS (Y) and whether such effect was mediated by SMHS (M). In detail, we analyzed data according to Baron and Kenny's test for mediation effect (37) using the following four models:

TABLE 1 Characteristics of the study sample.

	Frequency/ mean (SD)	Percent/ range	N
Sex[+]			10,283
Female	5,870	57.08	
Male	4,413	42.92	
Marriage status[+]			10,278
Unmarried	1,260	12.26	
Married	8,261	80.38	
Divorced	290	2.82	
Widowed	443	4.31	
Cohabiting	24	0.23	
Having a religious belief[+]			10,283
No	8,936	86.90	
Yes	1,347	13.10	
Age (years)[§]	46.59 (14.25)	18–69	10,283
Economic status[§]	2.341 (0.927)	1–5	10,134
Education level[§]	3.243 (1.414)	1–7	10,264
SMS[§]	6.735 (2.617)	1–10	9,899
SMHS[§]	3.022 (0.720)	1–4	9,725
LS[§]	32.05 (8.834)	5–50	10,282
General LS[§]	7.091 (2.234)	1–10	10,282

[+] Frequency and percent are reported; [§] Mean (SD) and range are reported.
SD, standard deviation; LS, life satisfaction; SMHS, satisfaction with medical and health services; SMS, satisfaction with medical security.

(1) the effect of X on Y (model 1), (2) the effect of X on M (model 2), (3) the effect of M on Y when adjusted for X (model 3), and (4) the effect of X on Y when adjusted for M (model 4). Furthermore, we conducted a series of robustness tests, including replacing the dependent variable with general LS (step 1) and replacing both the dependent variable with general LS and the mediating variable with SMS (step 2). $P < 0.05$ was considered statistically significant. All analyses were performed using Stata/MP 14.0.

3. Results

Of the participants, 57.08% were females and 13.10% had a religious belief (Table 1). The mean age of the sample was 46.59 years, and most of them were married (80.38%). The mean scores for education level and economic status were 3.243 and 2.341, respectively. Participants showed moderate to high levels of satisfaction with medical security (mean = 6.735) and medical and health services (mean = 3.022). The mean scores for LS and general LS were 32.053 (standard deviation = 8.834) and 7.091 (standard deviation = 2.234), indicating participants had a relatively positive attitude toward their life.

Figure 1 exhibits the provincial distribution of the PMHP level. The median number of PMHIs per 10,000 people was 6.768
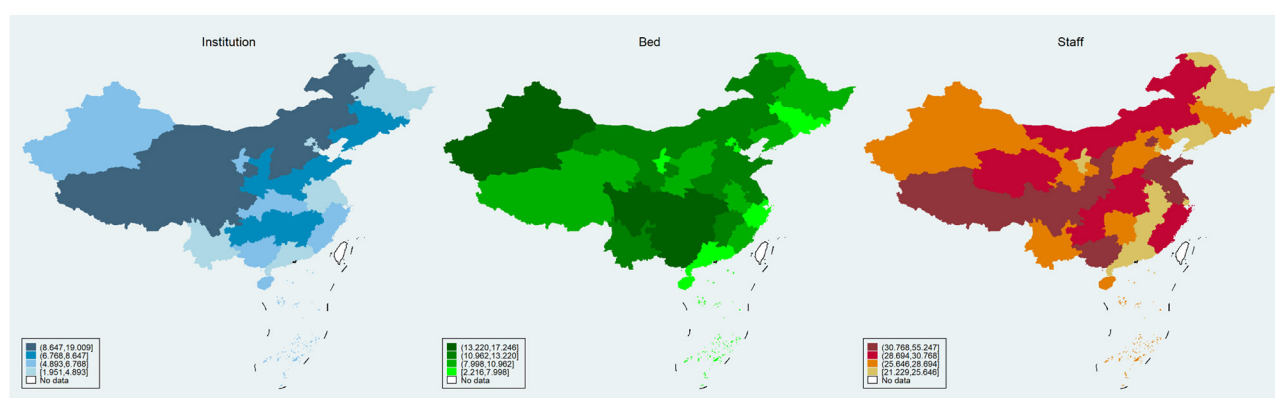
FIGURE 1
Distribution of provincial primary medical and health preparedness. **(Left, middle, and right)** Show the distribution of PMHIs (number per 10,000 people, the number of beds in PMHIs per 10,000 people, and the number of staffs in PMHIs per 10,000 people, respectively).

[interquartile range (IQR): (4.89, 8.647)]. The median number of beds in PMHIs was 10.962 [IQR = (7.998, 13.220)], and the median value for the number of staff in PMHIs was 28.694 [IQR = (25.646, 30.768)]. According to these results, one bed in PHMIs serves almost 1,000 people, and one member of staff in PMHIs serves nearly 300 people.

The relationships between PMHP, SMHS, and LS are shown in Table 2. In model 1, the number of PMHIs and the number of beds in PMHIs were not significantly associated with LS, while the number of staff in PMHIs showed a significant positive effect on LS (β = 0.107, P < 0.05). Similarly, the analysis using in model 2 showed a significant correlation only between the number of staff in PMHIs and SMHS (β = 0.015, P < 0.001). After incorporating both PMHP and SMHS into the model, the relationship between SMHS and LS was significant (β = 1.792, P < 0.001), although the effects of all the three aspects of PMHP on LS were not significant. According to these results, SMHS has a full mediation effect on the association between the number of staff in PMHIs and LS.

The results of the robustness tests are shown in Table 3. Whether replacing only the dependent variable (step 1) or both the dependent and mediating variables (step 2), the results demonstrated that only the number of staff in PMHIs affected LS positively. Furthermore, this effect was fully mediated by SMHS. These findings indicate that the associations between all the three aspects of PMHP and LS were robust.

4. Discussion

To the best of our knowledge, this is the first study to examine the impact of PMHP on people's LS from a macro perspective. We measured PMHP in terms of the number of PMHIs, the number of beds in PMHIs, and the number of staffs in PMHIs. Using nationally representative data in China, we analyzed the direct impacts of the three aspects of PMHP on LS, and the indirect effects of PMHP on LS mediated through improved satisfaction with medical and health services. We have obtained some interesting and novel findings.

In this study, the number of staff in PMHIs was shown to play a significant positive role in improving people's LS. Specifically,

TABLE 2 Associations between primary medical and health preparedness, satisfaction with medical and health service, and life satisfaction.

	Model 1	Model 2	Model 3/4
	LS	SMHS	LS
PMHP			
Number of PMHIs	−0.082 (0.090)	−0.003 (0.008)	−0.079 (0.085)
Number of beds in PMHIs	−0.096 (0.055)	−0.004 (0.005)	−0.093 (0.052)
Number of staff in PMHIs	0.107* (0.047)	0.015*** (0.004)	0.082 (0.044)
SMHS			1.792*** (0.111)
Sex (male)	0.452** (0.162)	−0.027 (0.015)	0.456** (0.164)
Age (years)	0.080*** (0.007)	0.002* (0.001)	0.079*** (0.008)
Education level	1.463*** (0.069)	−0.045*** (0.006)	1.525*** (0.070)
Economic status	3.219*** (0.085)	0.063*** (0.008)	3.115*** (0.087)
Having a religious belief (yes)	−0.110 (0.242)	−0.032 (0.022)	−0.177 (0.244)
Marriage status (ref: unmarried)			
Married	−2.928*** (0.294)	−0.108*** (0.027)	−2.754*** (0.295)
Divorced	−4.658*** (0.537)	−0.074 (0.050)	−4.350*** (0.550)
Widowed	−1.928*** (0.505)	−0.091 (0.047)	−1.790*** (0.516)
Cohabiting	−0.435 (1.682)	0.039 (0.160)	−0.733 (1.741)
N	10,110	9,594	9,594

PMHIs, Primary medical and health institutions; LS, life satisfaction; SMHS, satisfaction with medical and health services.

*P < 0.05, **P < 0.01, ***P < 0.001.

TABLE 3 Robustness tests.

	Step 1		Step 2	
	General LS	General LS	SMS	General LS
Number of PMHIs	0.010 (0.025)	0.014 (0.023)	0.022 (0.029)	0.006 (0.022)
Number of beds in PMHIs	−0.020 (0.015)	−0.018 (0.014)	−0.015 (0.018)	−0.017 (0.013)
Number of staffs in PMHIs	0.026* (0.013)	0.017 (0.012)	0.051*** (0.015)	0.014 (0.011)
SMHS		0.443*** (0.029)		
SMS				0.219*** (0.008)
N	10,110	9,594	9,763	9,763

PMHIs, Primary medical and health institutions; LS, life satisfaction; SMHS, satisfaction with medical and health services; SMS, satisfaction with medical security; adjusted for all control variables.

*$P < 0.05$; ***$P < 0.001$.

people living in provinces with more primary medical and health workers per 10,000 people exhibit a higher level of LS. This is similar to previous findings, which have shown that the better resident-to-staff ratio is associated with higher quality of life (22). Furthermore, the effect of the number of staff in PMHIs on LS is fully mediated by SMHS. In other words, the number of staff in PMHIs does not directly influence people's LS, but affects LS by affecting people's satisfaction with medical and health services. This finding is understandable because a better resident-to-staff ratio means that each employee manages fewer patients, which means less stress for employees (38), and they can better serve patients and meet their needs (39), resulting in better patient satisfaction with medical and health services (30, 40). This in turn translates into better perceptions of health status and life satisfaction (32, 41). Moreover, more staff in PMHIs results in a better experience of obtaining medical and health services (i.e., accessibility), such as increased opportunities and reduced waiting time to obtain services, with the accessibility of medical and health services being an important determinant of LS (19, 20, 42). Accordingly, this study highlights the importance of human resources in the construction of primary medical and health services (43). Indeed, human resources have an critical role in the development of health systems (44, 45) and can improve the performance of healthcare institutions in terms of providing medical and health services (46). Sheikhbardsiri et al. (47) concluded that it should settle the shortage of human resources in health services, because human resource supply is one of the most vital factors in achieving institutional goals and the most valuable factor in the producing and delivering of services (48). Therefore, this study suggests that initiatives to strengthen PMHPs should start by increasing the number of staff, such as general practitioners, in PMHIs.

Surprisingly, the other two aspects of PMHP (i.e., the number of PMHIs and the number of beds in PMHIs) have no significant effect on LS, which means that these aspects not only have no direct effect on LS, but also do not influence LS by affecting satisfaction

with medical and health services. There results are inconsistent with prior studies that showed that residents living in places with more care institutions and facilities exhibited better wellbeing (23). Therefore, in contrast to previous research (49), our study does not support increasing the number of PMHIs as a strategy for developing primary medical and health services. Indeed, there are 970,000 PMHIs in China, basically achieving full coverage of urban and rural communities (50). Furthermore, our findings do not suggest that increasing the number of beds in PMHIs will improve LS. Currently, the phenomenon of empty beds in China's PMHIs indicates that the supply of beds exceeds demand. Therefore, it is important to improve the utilization rate of beds rather than increasing the number of beds. This, however, is beyond the scope of the present study.

Some limitations of this study should be noted. First, PMHP encompasses a wide range of elements, but this study was focused on only three aspects: the number of PMHIs, the number of beds in PMHIs, and the number of staff in PMHIs. Future research could be conducted to explore the impact of other aspects of PMHP (e.g., service capacity, funding, and staff structure) on LS. Second, the number of staff in PMHIs corresponds to the total number of doctors, nurses, pharmacists, and other employees; however, due to the limitation of data acquisition, we were unable to confirm which type of staff had a greater impact on LS. Third, although many factors affect LS, we included only socio-demographics as control variables and omission variables may lead to biased results.

5. Conclusion

In conclusion, PMHP has a positive impact on LS, but this impact is derived only from the number of staff in PMHIs, and not the number of PMHIs or the number of beds in PMHIs. Moreover, the effect of the number of staff in PMHIs on LS is indirect and must be mediated by satisfaction with medical and health services. This study suggests that the government should focus on the construction of human resources in PMHIs.

Data availability statement

Publicly available datasets were analyzed in this study. This data can be found here: the data of the 2019 Chinese Social Survey (http://css.cssn.cn/css_sy/) and the 2018 Health Statistics Yearbook for each province in China (http://www.nhc.gov.cn/mohwsbwstjxxzx/tjtjnj/202106/ff9efb87ead24385b83ddb9eb0e3df5f.shtml).

Ethics statement

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

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Author contributions

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Conflict of interest

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

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References

1. Meule A, Voderholzer U. Life satisfaction in persons with mental disorders. *Qual Life Res.* (2020) 29:3043–52. doi: 10.1007/s11136-020-02556-9

2. Steptoe A. Happiness and health. *Annu Rev Public Health.* (2019) 40:339–59. doi: 10.1146/annurev-publhealth-040218-044150

3. Nakamura JS, Delaney SW, Diener E, VanderWeele TJ, Kim ES. Are all domains of life satisfaction equal? Differential associations with health and well-being in older adults. *Qual Life Res.* (2022) 31:1043–56. doi: 10.1007/s11136-021-02977-0

4. Goldberg JF, Harrow M. Subjective life satisfaction and objective functional outcome in bipolar and unipolar mood disorders: a longitudinal analysis. *J Affect Disord.* (2005) 89:79–89. doi: 10.1016/j.jad.2005.08.008

5. Haar JM, Roche MA. Family supportive organization perceptions and employee outcomes: the mediating effects of life satisfaction. *Int J Human Resour Manage.* (2010) 21:999–1014. doi: 10.1080/09585191003783462

6. Schutte L, Negri L, Delle Fave A, Wissing MP. Rasch analysis of the satisfaction with life scale across countries: findings from South Africa and Italy. *Curr Psychol.* (2021) 40:4908–17. doi: 10.1007/s12144-019-00424-5

7. Kotakorpi K, Laamanen J-P. Welfare state and life satisfaction: evidence from public health care. *Economica.* (2010) 77:565–83. doi: 10.1111/j.1468-0335.2008.00769.x

8. Yang Y, Zhao L, Cui F. How does public health investment affect subjective well-being? Empirical evidence from China. *IJERPH.* (2022) 19:5035. doi: 10.3390/ijerph19095035

9. Wang D, Li D. Social capital, policy fairness, and subjective life satisfaction of earthquake survivors in Wenchuan, China: a longitudinal study based on post-earthquake survey data. *Health Qual Life Outcomes.* (2020) 18:1–12. doi: 10.1186/s12955-020-01594-8

10. Qi W, Liu F, Zhang T, Qi X. Can China's new rural cooperative medical system improve farmers' subjective well-being? *Front Public Health.* (2022) 2022:848539. doi: 10.3389/fpubh.2022.848539

11. Zhang K, Pei J, Wang S, Rokpelnis K, Yu X. Life satisfaction in China, 2010–2018: trends and unique determinants. *Appl Res Qual Life.* (2022) 2022:1–38. doi: 10.1007/s11482-021-10031-x

12. Li J, Raine JW. The time trend of life satisfaction in China. *Soc Indic Res.* (2014) 116:409–27. doi: 10.1007/s11205-013-0300-4

13. Xia X, Yu Y, Zou Y. Air pollution, social engagement and subjective well-being: evidence from the Gallup World Poll. *Environ Sci Pollut Res.* (2022) 2022:1–24. doi: 10.1007/s11356-022-19451-0

14. Knoll B, Pitlik H. Who benefits from big government? A life satisfaction approach. *Empirica.* (2016) 43:533–57. doi: 10.1007/s10663-015-9304-4

15. Di Martino S, Prilleltensky I. Happiness as fairness: the relationship between national life satisfaction and social justice in EU countries. *J Commun Psychol.* (2020) 48:1997–2012. doi: 10.1002/jcop.22398

16. Mouratidis K. Compact city, urban sprawl, and subjective well-being. *Cities.* (2019) 92:261–72. doi: 10.1016/j.cities.2019.04.013

17. Kobayashi LC, Altindag O, Truskinovsky Y, Berkman LF. Effects of the affordable care act medicaid expansion on subjective well-being in the US adult population, 2010–2016. *Am J Public Health.* (2019) 109:1236–42. doi: 10.2105/AJPH.2019.305164

18. Ortuzar I, Renart G, Xabadia A. Effects of public healthcare budget cuts on life satisfaction in Spain. *Soc Indic Res.* (2021) 156:311–37. doi: 10.1007/s11205-021-02624-8

19. Tang L. The influences of patient's satisfaction with medical service delivery, assessment of medical service, and trust in health delivery system on patient's life satisfaction in China. *Health Qual Life Outcomes.* (2012) 10:1–13. doi: 10.1186/1477-7525-10-111

20. Tang L. The Chinese community patient's life satisfaction, assessment of community medical service, and trust in community health delivery system. *Health Qual Life Outcomes.* (2013) 11:1–12. doi: 10.1186/1477-7525-11-18

21. Kim S, Kim D. Does government make people happy? Exploring new research directions for government's roles in happiness. *J Happiness Stud.* (2012) 13:875–99. doi: 10.1007/s10902-011-9296-0

22. Kane RL, Bershadsky B, Kane RA, Degenholtz HH, Liu JJ, Giles K, et al. Using resident reports of quality of life to distinguish among nursing homes. *Gerontologist.* (2004) 44:624–32. doi: 10.1093/geront/44.5.624

23. Vogel N, Ram N, Goebel J, Wagner GG, Gerstorf D. How does availability of county-level healthcare services shape terminal decline in well-being? *Eur J Ageing.* (2018) 15:111–22. doi: 10.1007/s10433-017-0425-4

24. National Health Commission of the People's Republic of China. *Governing Rules for the Evaluation of Medical Institutions.* (1995). Available online at: http://www.nhc.gov.cn/fzs/s3576/201808/0415d028c18a46c4a316d8339edcdf44.shtml (accessed May 7, 2022).

25. Wang H, Gusmano MK, Cao Q. An evaluation of the policy on community health organizations in China: will the priority of new healthcare reform in China be a success? *Health Policy.* (2011) 99:37–43. doi: 10.1016/j.healthpol.2010.07.003

26. Yuan J, Zhang L, Xu W, Shen J, Zhang P, Ma H. Reported changes in health-related behaviours in Chinese urban residents in response to an influenza pandemic. *Epidemiol Infect.* (2009) 137:988–93. doi: 10.1017/S0950268809002726

27. Tang L. The influences of patient's trust in medical service and attitude towards health policy on patient's overall satisfaction with medical service and sub satisfaction in China. *BMC Public Health.* (2011) 11:1–8. doi: 10.1186/1471-2458-11-472

28. Lazarevik V, Kasapinov B. Predictors of patients' satisfaction with health care services in three Balkan countries (Macedonia, Bulgaria and Serbia): a cross country survey. *Acta Inform Med.* (2015) 23:53–6. doi: 10.5455/aim.2015.23.53-56

29. Qadire M, Khalaileh M. Determinants of public satisfaction and perception of national healthcare services availability in Jordan: a patient survey. *Br J Med Med Res.* (2017) 20:31529. doi: 10.9734/BJMMR/2017/31529

30. Ugurluoglu Ö, Ürek D, Bilgin Demir I. Evaluation of individuals' satisfaction with health care services in Turkey. *Health Policy Technol.* (2019) 8:24–9. doi: 10.1016/j.hlpt.2019.02.003

31. Xesfingi S, Vozikis A. Patient satisfaction with the healthcare system: assessing the impact of socio-economic and healthcare provision factors. *BMC Health Serv Res.* (2016) 16:94. doi: 10.1186/s12913-016-1327-4

32. Cheng G, Yan Y. Sociodemographic, health-related, and social predictors of subjective well-being among Chinese oldest-old: a national community-based cohort study. *BMC Geriatr.* (2021) 21:1–13. doi: 10.1186/s12877-021-02071-7

33. Chinese Academy of Social Sciences. *Chinese Social Survey*. (2019). Available online at: http://css.cssn.cn/css_sy/ (accessed April 30, 2022).

34. Ekici T, Koydemir S. Social capital, government and democracy satisfaction, and happiness in Turkey: a comparison of surveys in 1999 and 2008. *Soc Indic Res*. (2014) 118:1031–53. doi: 10.1007/s11205-013-0464-y

35. Abdollahyar A, Baniasadi H, Doustmohammadi MM, Sheikhbardesiri H, Yarmohammadian MH. Attitudes of Iranian nurses toward spirituality and spiritual care. *J Christ Nurs*. (2019) 36:E11–6. doi: 10.1097/CNJ.0000000000000581

36. Peng J, Wu WH, Doolan G, Choudhury N, Mehta P, Khatun A, et al. Marital status and gender differences as key determinants of COVID-19 impact on wellbeing, job satisfaction and resilience in health care workers and staff working in academia in the UK during the first wave of the pandemic. *Front Public Health*. (2022) 10:928107. doi: 10.3389/fpubh.2022.928107

37. Baron RM, Kenny DA. The moderator–mediator variable distinction in social psychological research: conceptual, strategic, and statistical considerations. *J Pers Soc Psychol*. (1986) 51:1173–82. doi: 10.1037/0022-3514.51.6.1173

38. Pekkarinen L, Sinervo T, Perälä M-L, Elovainio M. Work stressors and the quality of life in long-term care units. *Gerontologist*. (2004) 44:633–43. doi: 10.1093/geront/44.5.633

39. Harrington C, Zimmerman D, Karon SL, Robinson J, Beutel P. Nursing home staffing and its relationship to deficiencies. *J Gerontol B Psychol Sci Soc Sci*. (2000) 55:S278–287. doi: 10.1093/geronb/55.5.s278

40. Kutney-Lee A, McHugh MD, Sloane DM, Cimiotti JP, Flynn L, Neff DF, et al. Nursing: a key to patient satisfaction. *Health Aff*. (2009) 28:w669–77. doi: 10.1377/hlthaff.28.4.w669

41. Park K, Park J, Kwon YD, Kang Y, Noh J-W. Public satisfaction with the healthcare system performance in South Korea: Universal healthcare system. *Health Policy*. (2016) 120:621–9. doi: 10.1016/j.healthpol.2016.01.017

42. Kartschmit N, Beratarrechea A, Gutiérrez L, Cavallo AS, Rubinstein AL, Irazola V. Health care access and health-related quality of life among people with diabetes in the Southern Cone of Latin America—a cross-sectional analysis of data of the CESCAS I study. *Qual Life Res*. (2021) 30:1005–15. doi: 10.1007/s11136-020-02704-1

43. Alatawi AD, Niessen LW, Bhardwaj M, Alhassan Y, Khan JAM. Factors influencing the efficiency of public hospitals in Saudi Arabia: a qualitative study exploring stakeholders' perspectives and suggestions for improvement. *Front Public Health*. (2022) 10:922597. doi: 10.3389/fpubh.2022.922597

44. Rezaei F, Maracy MR, Yarmohammadian MH, Sheikhbardsiri H. Hospitals preparedness using WHO guideline: a systematic review and meta-analysis. *Hong Kong J Emerg Med*. (2018) 25:211–22. doi: 10.1177/1024907918760123

45. Aminizadeh M, Saberinia A, Salahi S, Sarhadi M, Jangipour Afshar P, Sheikhbardsiri H. Quality of working life and organizational commitment of Iranian pre-hospital paramedic employees during the 2019 novel coronavirus outbreak. *Int J Healthcare Manage*. (2022) 15:36–44. doi: 10.1080/20479700.2020.1836734

46. Méndez CA, Torres AMC. Hospital management autonomy in Chile: the challenges for human resources in health. *Rev Saude Publica*. (2010) 44:366–71. doi: 10.1590/s0034-89102010000200019

47. Molavi-Taleghani Y, Ebrahimpour H, Sheikhbardsiri H. A proactive risk assessment through healthcare failure mode and effect analysis in pediatric surgery department. *J Compr Ped*. (2020) 11:56008. doi: 10.5812/compreped.56008

48. Nobakht S, Shirdel A, Molavi-Taleghani Y, Doustmohammadi MM, Sheikhbardsiri H. Human resources for health: a narrative review of adequacy and distribution of clinical and nonclinical human resources in hospitals of Iran. *Int J Health Plann Manage*. (2018) 33:560–72. doi: 10.1002/hpm.2510

49. Pan Y, Liu L, Wei J. Operational efficiency of primary medical and health institutions in China since the new medical reform. *Chin Rural Health Serv Admin*. (2022) 42:273–8. doi: 10.19955/j.cnki.1005-5916.2022.04.008

50. Fu W. *Promote the High-Quality Development of Urban and Rural Community Medical and Health Service Systems During the "14th Five-Year Plan" Period*. (2022). Available online at: http://www.gov.cn/xinwen/2022-02/09/content_5672796.htm (accessed May 8, 2022).

"I was bullied for being fat in every situation, in every outfit, at every celebration": A qualitative exploratory study on experiences of weight-based oppression in Qatar

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Introduction: Weight-based oppression (WBO) has been documented as a widespread phenomenon in Western countries and is associated with a range of psychological, physiological, and behavioral harms. Research on weight-based oppression is largely absent from the Arab region.

Methods: We conducted a qualitative exploratory study using semi-structured in-depth interviews to examine the internalized attitudes, values, and beliefs related to body weight, and experiences of external weight-based oppression of 29 staff, faculty, and students at Qatar University.

Results: Thematic analysis revealed six major themes on the characteristics of internalized WBO, and the nature, timing, source, extent, and impact of external WBO. WBO was regarded as so common in the Arab culture as to be normative, with damaging exposure to WBO beginning in early childhood.

Conclusion: WBO in the Arab region is an important and unrecognized public health issue. Programs to reduce WBO should be developed in all sectors.

KEYWORDS

weight stigma, weight-based oppression, weight bias, Arab region, Qatar

1. Introduction

Weight-based oppression (WBO), including negative beliefs, teasing, harassment, stigma, prejudice, and discrimination based on body weight, is a widespread phenomenon that leads to considerable distress, health harming behaviors and poor health outcomes (1). WBO arises from both external and internal sources. External sources of WBO include exposure to stigmatizing or exclusionary social, cultural, economic, political, and built environments, weight bias and discrimination, and weight-based bullying and violence. In Western countries, the prevalence of weight stigma is high, and appears to be increasing (2). Up to a half of young people in the USA have been subjected to weight-based harassment, the highest rate of any type of harassment, and similar to or greater than rates of ethnicity-based harassment (3, 4). Up to one third of young people have been subjected to weight based discrimination (4). Weight-based harassment is prevalent across genders, with up to 65% of non-binary and transgender youth experiencing weight-based victimization (4). Those with higher weights, women, transgender, non-binary, queer, and younger people are subjected to the highest levels of weight-based discrimination (4–6). Weight bias has been demonstrated to exist across all aspects of society including in health care practitioners, educators, employers, landlords, and the general public (7).

WBO from external sources is linked with decreased body satisfaction, lower self-esteem, greater weight concerns, more loneliness, higher depressive symptoms, suicidal thoughts and attempts, higher preference for sedentary activities or activities performed alone, and bulimic behavior, regardless of actual body weight (8). Mental health issues such as depression are associated with being exposed to weight-based teasing, bullying and stigmatization. These associations are apparent across gender, ethnic, racial, and weight groups (9). The more sources of teasing that people are exposed to, the greater the prevalence of emotional health issues. In one study, participants that were exposed to teasing from their peers had considerably higher levels of depression and were five times more likely to adopt health harming weight manipulation behaviors compared to those who were not exposed to teasing (10). The frequency of teasing and the number of teasing sources significantly increased the risk of depression. Weight-based teasing strongly predicts binge eating and intensive weight manipulation over 5 years (11). Negative comments from parents about weight or shape and eating are associated with psychological distress and eating disorder cognitions in adolescents (12). A systematic review found an association between weight teasing by parents and problematic eating behaviors in adolescents (13).

Internalized WBO is the negative attitudes, values, and beliefs people hold about one's own weight (14), which have negative consequences for health and wellbeing (15). Internalized negative attitudes about body weight are so strong that being fat is considered worse than having breast cancer (16), and a proportion of people would rather lose a limb, be blind, alcoholic, severely depressed, unable to have children, or lose 10 years of life or more than be fat (17). Internalized WBO is linked to low self-esteem, anxiety, depression, avoidance of physical activity, body image disturbance, decreased use of preventive health services, increased calorie consumption, disordered eating, and weight gain (18–21). Evidence is mounting of the psychological (22–27), behavioral (21, 25, 28–32) and physiological effects of WBO. Physiological effects include higher blood pressure (33, 34), type 2 diabetes mellitus (35), metabolic syndrome (36, 37), allostatic load (lipid/metabolic dysregulation, glucose metabolism and inflammation) (38), cortisol reactivity (39), and oxidative stress (40).

Research on external WBO is largely absent from the Arab world, including Qatar. The only study to address any aspect of external WBO found that 44% of female Emirati students reported being frequently teased about their weight, and that eating disorder symptomatology was positively correlated with being bothered by weight-based teasing and internalized weight stigma (14). Although there have been numerous studies in the Arab region on internalized WBO, they have tended to focus exclusively on body dissatisfaction and disordered eating attitudes [for recent examples see (41–45)]. A recent review of 22 studies involving over 10,000 adolescents from nine Arab countries found that the overall prevalence of disordered eating attitudes was 26.94%, a higher prevalence than in the USA or sub-Saharan Africa (46).

The "global culture of modernity" (47) has come to characterize many rapidly urbanizing parts of the world, including the Arab region, and is viewed as eliciting a rise in average body weight, weight consciousness, and disordered eating. Gordon (48) reviewed epidemiological data for nations where eating disorders first began being reported in the 1990s. He identified four pivotal characteristics that these nations had in common: (1) rising average body weights, (2) highly developed economies or rapid economic change, (3) changing and conflicting gender roles for women, and (4) a global consumer culture with an emphasis on slenderness as a female body ideal. All four of Gordon's factors resonate strongly with Qatar's rapid socio-economic and epidemiological transition. Rates of WBO may therefore be rising concomitantly, with the attendant poor physical, mental, and social health outcomes, including chronic non-communicable diseases such as cardiovascular disease and diabetes. However, no studies have examined any of the concepts related to internalized or external WBO in Qatar. This study aims to examine experiences of external WBO, including teasing, bullying, stigmatization, and discrimination, and the internalized attitudes, values, and beliefs related to body weight in a sample of people in Qatar.

Given the significant body of evidence demonstrating the relationship between population changes in body weight, WBO, and negative health outcomes, it is imperative that research studies begin to explore the full scope of WBO in Qatar and the Arab region. This qualitative study is the first to do so and will provide the foundation for future quantitative studies to examine the extent and impact of these issues in the population more broadly.

2. Research design

2.1. Research questions

The research questions we explored were 1. What are the internalized WBO related attitudes, values, and beliefs of people in Qatar? and 2. What are the external WBO experiences of people in Qatar?

2.2. Methodology

Constructivist epistemology guided this research study, based on the belief that "reality" is socially constructed (49). The consolidated criteria for reporting qualitative research (COREQ) guidelines are used to report the study design and findings (50). This qualitative study used interview methodology (51), which was most appropriate to explore the range of experiences of participants on this issue. Interview methodology provides a deeper and richer understanding of public health issues than purely quantitative methods and is most appropriate where little is already known about the issue, where the issue is sensitive, or where detailed insights are required from individual participants. All these conditions were applicable to exploring WBO in Qatar.

2.3. Theoretical framework

The Red Lotus Critical Health Promotion Model (RLCHPM) was used as a theoretical framework for this study (52). The RLCHPM is a modern, holistic, socio-ecological model, that differs from other health promotion models in terms of incorporating a

system of values and principles, and applying them in all stages of critical health promotion including community assessment, planning, and implementation, and evaluation (52–54). In the RLCHPM, the pod of the lotus flower represents the holistic health and wellbeing status of people. The stamens of the lotus flower that surround the pod represent the determinants of health and wellbeing related to people's characteristics, including biological, cognitive, affective, and socioeconomic factors and behaviors. The first layer of petals of the lotus flower represents the environmental determinants of health including social, cultural, political, economic, commercial, natural, and built environments. The second layer of lotus flower petals represents the components of the community assessment process. The third, fourth and fifth layers of lotus flower petals represent the components of health promotion program planning, program implementation and program evaluation processes, respectively. The leaves of the lotus plant represent a focus on sustainability. The stem of the plant represents the process of critical reflection. The tuber and roots are the foundation of the plant and represent the values and principles of critical health promotion, including social justice and equity, holistic, salutogenic, and ecosystems conceptions of health and scientific endeavor, allyship and empowerment, beneficence and non-maleficence, and evidence-informed and theory-based practice that are applied across all components of the model. The lotus plant is a dynamic, living organism that exists within a complex ecosystem. All parts of the plant and its environment are interconnected and influence each other (52–54).

This study aimed to investigate WBO as a specific health and wellbeing issue. Understanding the nature and extent of health and wellbeing issues is part of the community assessment phase of the health promotion practice cycle. Using the RLCHPM as the theoretical foundation meant that the study prioritized the participation of people with higher weight (value: priority populations determined by structural inequality), and considered WBO holistically, which meant we were open to the possibility that WBO may have had physical, mental, spiritual, and social health consequences (value: holistic health paradigm), though we did not specifically probe for each aspect. Using the RLCHPM also meant that the study investigated the characteristics of people (stamens) and environments (first petal layer) that contribute to WBO, and how these factors interact and operate at multiple levels from the individual level to the family, community, organization, and society levels (value: systems science).

2.4. Research team and reflexivity

The study team (LOH, BAA, BAS) engaged in reflexive practice (55) at weekly meetings, focusing on issues such as adherence to critical health promotion values and principles, as well as quality considerations. This allowed us to examine our own beliefs and assumptions, and think carefully about how these may be influencing our research process, including the risk of prioritizing our own views or opinions. The epistemological position of constructivism meant that the design of the study, data collection and analysis, and interpretation of the findings were all constructed by the researchers and influenced by our personal and professional

experiences. LOH is a health promotion academic and practitioner and fat liberation advocate who has been involved in critical fat studies and fat activism in schools, universities, and the community for over 20 years. LOH and BAA have lived experience of external and internalized weight-based oppression, while BAS has witnessed such experiences with family and friends. BAA and BAS were senior undergraduate public health students at the time of the study and became interested in weight-based oppression through interaction and classes with LOH.

2.5. Study participants

Participants were recruited from the staff, faculty, and students at Qatar University (QU). Participation was limited to the QU community as this was an exploratory study. The researchers had no significant relationships with most of the participants prior to the study. In the first recruitment phase, participants were known to the researchers as colleagues in other departments or fellow students from other programs. One participant recruited in the first phase was well known to the researchers as a former student. This participant was eager to participate in the study, despite this existing relationship. In the second recruitment phase, the researchers had no relationships with any of the participants prior to the study.

2.6. Recruitment and sampling methods

A combination of homogenous and heterogeneous purposive sampling methods were used. All participants shared the common feature of having been exposed to WBO. Following this initial inclusion criterion, heterogeneous sampling was used to maximize variability within the participants. Purposive sampling is one of the most cost-effective and time-effective sampling methods available and is appropriate for studies such as this where the discovery of meaning will benefit from an intuitive approach. In the first phase of recruitment, potential participants with larger bodies were identified through personal knowledge of the researchers. They were informed about the study, and shown pictures illustrating types of WBO including teasing, and discrimination. We asked if they had experienced anything similar, and if so, would they be interested in participating in the study. This method resulted in nine interviews that were conducted in-person. We had not reached data saturation at that point, as new information was emerging with each interview (56), and so we decided to try a new recruitment strategy. Email and QU social media were used to disseminate a poster calling for QU students, staff, and faculty to participate in the study. The poster had the title "Ever been treated badly because of your weight?" and the text read "Teasing, harassment, stigma, and discrimination based on body weight are widespread and cause considerable distress. We are conducting a study exploring how people with a higher body weight are treated by their families, friends, teachers, healthcare providers, the media, and society in general. The study is the first study in the Arab region to explore these issues." The poster included a cartoon image of a child with a larger body being teased by a

group of children. After screening respondents, those that added the most heterogeneity to the sample were contacted and recruited to participate. This recruitment and sampling method resulted in a further 20 completed interviews, at which point data saturation was deemed to have occurred, as no new concepts were appearing in the data (56, 57). Four people initially volunteered to participate in the second recruitment phase but did not respond to requests from the researchers to schedule an interview. The total sample size was therefore 29 participants. This is significantly larger than the range of nine to 17 participants generally required to reach data saturation in studies using qualitative interviews (56), due to the intentional heterogeneity of our sample.

2.7. Data collection method

Individual in-depth semi-structured interviews were used to collect the data *via* a set of predetermined but loosely structured questions. Semi-structured interviews enable the comparison of data across participants, but also provide the flexibility to probe or dig deeper on specific issues as appropriate in each individual interview. The first interview was conducted by LOH (MPH, PhD), a female Associate Professor of Public Health with experience in qualitative studies, with BAA and BAS as observers. All subsequent interviews were conducted by BAA and BAS, female senior undergraduate students majoring in public health and trained in research methods and interviewing techniques. The first nine interviews were conducted in person between January and early March 2020. With the participants' permission, interviews were audio-recorded, and field notes were made during and immediately after each interview, including the observations, thoughts, and ideas about the interview. Just after the second recruitment phase was implemented, the COVID-19 pandemic hit Qatar and all on-campus activities were suspended. As such, our interviews moved online and were conducted using WhatsApp, an end-to-end encrypted communication app that is used by almost all residents of Qatar. Depending on the choice of the participant, interviews were conducted digitally *via* WhatsApp video call, audio call, texting or voice notes, or a combination of texting and voice notes, and took place in March and April 2020. All in-person and digital interviews ranged from 30 to 90 min and were conducted in English and/or Arabic according to the participant's preference. Interviews records were transcribed immediately after the completion of the interview and the transcript was provided to the participant to allow for corrections or additions. Transcripts in Arabic were translated into English for data analysis by BAA and BAS, who are native Arabic speakers.

2.8. Data collection instrument

The interview protocol (list of questions) was developed in both English and Arabic, and pilot tested with several respondents to establish if the questions were clear and understandable, and to assess if respondents were willing to answer the questions openly and honestly. Changes were made to the interview protocol after pilot testing before use in the study (Supplementary material 1). The translation from English to Arabic was undertaken independently by BAA and BAS and then compared and amended to develop a consensus. Prompts were used by the interviewers to obtain more detailed information.

2.9. Data analysis method

The four-step method of analyzing qualitative data was used. This involves preparation of data, data reduction, displaying data, and verifying data (58). Data preparation involved uploading the transcripts to the NVIVO 12 software program (QSR International). Data reduction in NVIVO included line by line coding, looking for similar concepts, grouping concepts into categories, and grouping categories into larger themes. Two researchers (BAA and BAS) independently familiarized themselves with the interview transcripts, recorded initial observations of the data, and identified codes. The analysis used both etic codes, developed based on *a priori* concepts from the interview guide, and emic codes generated from the words of the participants. In the displaying data phase, codes were grouped into categories and categories were grouped into themes. Codes, categories, and themes were discussed by all three researchers (LOH, BAA and BAS) and disagreements were resolved *via* consensus. Data verification was ensured by cross-checking the results with the original transcripts.

2.10. Rigor and trustworthiness

To ensure the rigor and trustworthiness of our results, the research design included using a research team and member-checking. In the weekly meetings of the research team held throughout the study, we engaged in researcher reflexivity, with attention to issues related to the quality of data collection, analysis, and interpretation. Working as a research team enabled us to reflect on our preconceived ideas and prevent the imposition of individual ideas or beliefs over those of participants. Member-checking was used to seek the confirmation of study participants regarding their transcripts. Participants were provided with full transcripts from their interview and offered the opportunity to make any amendments they wished, including adding or deleting text. In the results, we used direct quotations from participants to represent their experiences. All strategies added to the trustworthiness and rigor of the research process.

2.11. Ethical considerations

This study and its amendments had ethics approval from QU Institutional Review Board (QU-IRB 1070-EA/19). Several ethical issues were carefully considered in this study, including privacy, confidentiality, respect, and non-maleficence. To ensure participants' privacy, in person interviews were conducted in a private venue at Qatar University, and participants were reassured that their personal information would not be made public.

Anonymity and confidentiality were ensured by using a pseudonym selected by the participant, and data were secured in a password-protected file on a password-protected computer accessible only by the researchers. Respect was also ensured through informed consent given by the participants prior to conducting interviews, and any ambiguity about the study was explained and clarified. Participants were assured that participation in the study was voluntary and that they had the right to withdraw at any time.

Finally, it is an ethical responsibility for researchers to do no (additional) harm (59). As a research team we carefully considered the issue of non-maleficence, recognizing that participants may have already experienced significant harm because of WBO, and wanting to avoid inadvertently causing any further harm in the recruitment, data collection, data analysis, or reporting processes. Of specific consideration in this study was the possibility for harm resulting from the framing of body weight. Several studies have found that using pathologizing language about body weight is stigmatizing and leads to poor health outcomes (22, 60–63). As such, in this paper, we present these terms in a censored form (ob*sity and overw*ight) to minimize harm, in accordance with the position taken by researchers, health professionals, and social justice advocates that these terms are slurs (62, 64–66).

We were therefore very deliberate about our decision to not use terms such as "ob*se" or "overw*ight". We also chose to not use the term "fat". Although the word has been reclaimed by fat liberation activists addressing WBO (62), we believe that the term is predominantly regarded as pejorative in the Arab region. As such, in all study materials (including the recruitment email and social media posts, project information sheet, consent form, and interview protocol) and throughout the interviews we adopted the weight-inclusive approach (67) and referred to people as having larger bodies or being at a higher weight (62, 67).

3. Results

There were 29 participants from QU faculty, staff, and students (25 females, 4 males), mostly Arabic and born in Qatar, and aged 18–53 years (Table 1). All participants experienced both internalized and external WBO. The study revealed six major themes: characteristics of internalized WBO; nature of external WBO; timing of external WBO; sources of external WBO; extent of external WBO; and the impact of WBO. Each theme included a number of thematic categories. Table 2 summarizes the major themes, categories, and number of participants who experienced each thematic category. Although it was not the aim of the study to quantify the experiences of WBO, the number of participants that spoke about each thematic category is included to provide a sense of the extent of these experiences among the participants.

In reporting on the themes and thematic categories, representative quotes from the participants are included to illustrate the study's findings. The quotes are provided verbatim, with no amendments to correct for grammar or inclusion of the word "sic" to indicate perceived errors. This is consistent with the recommendation from the Associated Press as described in the Columbia Journalism Review, which states the use of "sic" can be interpreted as "snarky" and giving a sense of "we know better", at the expense of the quoted source (68). This is particularly

TABLE 1 Participant characteristics.

Characteristic		Participants	
		N = 29	%
Gender	Female	25	86
	Male	4	14
Age	Range 18–53 years		
	Mean = 28.3, SD = 10.36		
Student/faculty/staff	Students	20	69
	Faculty	4	14
	Staff	5	17
Duration of stay in Qatar	Born in Qatar	14	48
	20 years or more	3	10
	10–<20 years	4	14
	5–<10 years	1	3
	2–<5 years	4	14
	<2 years	3	10
Marital status	Never married	19	66
	Married	8	28
	Divorced	2	7

important given that English is not the first language of any of the participants in our study. Respecting the words used by participants acknowledges that language is socially constructed, and this approach is therefore consistent with the constructionist epistemology that informs the study. It is also consistent with the health promotion value in the Red Lotus Critical Health Promotion Model of working with people transparently as a culturally and socially sensitive and reflexive ally respectful of all aspects of diversity, as opposed to the selective health promotion practice of working on people as an outside expert without explicit attention to the relevant cultural and social context or all aspects of diversity (52, 54).

3.1. Theme 1: Internalized WBO

Research question one for the study was what are the internalized WBO related attitudes, values, and beliefs of people in Qatar? All participants expressed a combination of internalized WBO related attitudes, values, and beliefs including feeling dissatisfied, sad, embarrassed, ashamed, worthless, or frustrated about their larger bodies. Some participants used pathologizing and/or derogatory terms to describe their bodies, indicating internalized WBO related beliefs about the acceptability of using those terms to describe their bodies.

3.1.1. Dissatisfied

Body dissatisfaction was the most common internalized WBO attitude, and the dissatisfaction was long standing. The desire for

TABLE 2   Major themes and thematic categories.

Major themes	Thematic categories	Participants	
		N = 29	%
Internalized WBO	Dissatisfied	21	72
	Sad	21	72
	Embarrassed and ashamed	20	69
	Worthless	10	34
	Frustrated	11	38
	Pathologized labeling	13	45
Nature of external WBO	Bullying and teasing	24	83
	Discrimination	13	45
	Treated badly	7	24
Timing of external WBO	Childhood and teenage years	24	83
	Adulthood	23	79
	After marriage	8	28
Sources of external WBO	Family	27	93
	Friends	15	52
	Media	15	52
	Spouses	8	28
	Healthcare providers	5	17
	Teachers and professors	5	17
	Culture and society	4	14
	People at school	4	14
	People at the gym	3	10
	People on public transport	2	7
	People in public places	2	7
	People in the street	1	3
Extent of external WBO	Normative	22	76
Impact of WBO	Low self-esteem	27	93
	Self-isolation	25	86
	Depression and anxiety	21	72
	Restriction or dieting	19	66
	Bariatric surgery	16	55
	Eating disorders	14	48
	Suicidal ideation or attempt	13	45

weight loss and a slimmer body was very strong among participants, leading to a lack of appreciation for their body. Sara 2 expressed the long-term sense of dissatisfaction, saying, "I've just grown up with this idea that I don't look fine and that I weigh too much, and I should have a thinner waist and thinner legs, and all these things mean I don't really appreciate my appearance." Dani echoed the ongoing sense of dissatisfaction saying, "Every time I look at myself in the mirror, all I see is things I want to change."

3.1.2. Sad

Participants spoke frequently of how sad they felt about their bodies, and their perceived lack of opportunities as a result of their body size. These opportunities included feeling attractive and feminine, and fitting in with peers. Dana recalled of her adolescent years, "It was horrible, I knew I was overw*ight, I knew I looked fat, I couldn't wear stuff that makes me look good, and being a female, I wanted to wear what other girls are wearing." Participants also spoke about feeling sad but covering it up so that others were not aware of how they were feeling. As Butterfly said, "This doesn't make me feel good, I feel ugly and sad from the inside, but I pretend to be okay." The tone of participants' voices as they recounted these experiences reflected their words. Participants sounded miserable when they remembered such situations from the past or present and talked about their body in a negative way.

3.1.3. Embarrassed and ashamed

Exposure to external WBO evoked deep feelings of internalized shame and embarrassment for participants. These feelings were still present for many, irrespective of how long ago the WBO occurred. Situations in which shame and embarrassment occurred included being subjected to negative comments by teachers in school, eating meals with family or friends, and eating in public. Aysha said, "I used to feel embarrassed to eat even if I'm hungry, especially in front of people." Not finding appropriate clothing sizes in stores also led to participants feeling ashamed and embarrassed about themselves, rather than angry at the lack of options available to them. This was compounded by being treated badly by sales assistants, as Meem described, "When it comes to clothes, I feel ashamed and embarrassed when I don't find my size and some of the assistants there laugh at me because of this."

3.1.4. Worthless

Beyond feeling dissatisfied, sad, embarrassed, and ashamed, many participants expressed feelings of worthlessness. Being around people with smaller bodies increased these feelings due to participants constantly comparing themselves with others, and ascribing judgment about their own relative worth based on their body size. Dani expressed this feeling saying, "I always felt lesser than the people around, less worthy, or less important. I don't think I could ever see myself as a normal, worthy person."

3.1.5. Frustrated

Many participants expressed feeling frustrated with their bodies and their inability to make themselves smaller or more acceptable. They felt as though they should be able to control their body, lose weight if they tried, but were failing to do so. These feelings of frustration were internalized, and not necessarily shared with others. They also had a significant impact on the wellbeing of participants. Arif explained, "I feel frustrated and angry, but I keep it for myself, and it affects my whole day and my sleep".

3.1.6. Pathologizing and derogatory self-labeling

About half of the participants used pathologizing terms such as "overw*ight" or "ob*se" when referring to their own body. In addition, some participants used terms such as "fat" in a negative manner, and other terms that they regarded as derogatory. The use of these labels to describe themselves resulted in more negative feelings and internalized WBO. Meem said, "I look at the mirror and call myself names—fatty, bear, seal—and this makes me feel awful."

3.2. Theme 2: Nature of external WBO

Research question two for the study was what are the external WBO experiences of people in Qatar? External experiences are categorized under the themes of nature, timing, sources, extent, and impact of external WBO. This section addresses the nature of external WBO. All participants were bullied or teased, experienced discrimination, or were treated badly by others because of their larger body size.

3.2.1. Bullying and teasing

Weight-based bullying occurred in different settings and from various people. In addition, bullying and teasing had several forms such as being called names, verbal bullying, and hurtful comments from even the people closest to participants. When recalling such situations, participants were visibly upset or annoyed. Malak vividly recalled one such experience from her time at school, "One time, our teacher brought chocolates to the class, and some girls were taking more than one piece, so I wasn't left with anything. And when the teacher asked why I didn't get chocolate, the girls started saying that 'she doesn't need chocolate, that is better for her, so she can lose weight' and the other girls started laughing. But I did not do anything and said that I did not take one because I was fasting, although I was not fasting that day."

3.2.2. Discrimination

Being discriminated against and having limited opportunities when it comes to certain jobs or marriage were very common concerns among participants. Having a larger body was seen as an obstacle between the person and their goals or desires across all aspects of their lives including personal, social, and professional aspects. Sara 2 explained, "In the beginning of my academic life I wanted to get into the psychology major, and I went to speak to the head of department of psychology, so he can tell me if I have a chance. I was speaking to him academically in terms of GPA, courses I've finished, and he said literally "yeah but this is not gonna work, you need to lose weight". He was like, "we don't have unhealthy people in psychology". Mustafa described a similar experience of being denied entry to his profession of choice saying, "When it comes to applying for the military medical services, there is a specific weight; if you are higher, they don't accept you." Discrimination during the school years was equally painful for participants. Malak recalled, "I remember at sports classes when it comes to choosing teams, no one picks me because I am fat and say that I will slow them down." When sharing these experiences of being discriminated against, participants were very downcast and seemed to feel defeated, especially when talking about losing the opportunity to pursue their dream jobs.

3.2.3. Treated badly

In addition to teasing, bullying, and discrimination, participants were treated badly in other situations because of their larger body size, including at clothing stores, on public transport, at home, and in other public places. Zayed said, "I used to volunteer in animal shelter for dog walks, pet owners were having mean talks with me regarding how will I walk the dog if I cannot walk myself." Arif felt as though he is treated badly everywhere he goes, explaining, "When I use public transport, and any outside places, everywhere, I feel that I am treated differently compared to others. Like, when I was using the bus, and it was crowded, one man was pushing me and saying that it's okay nothing will happen to me because I have a large body, and that we are not fitting in the bus because of fat people." Stereotypes about people with larger bodies also resulted in being treated badly. For example, Malak shared an example from her school years, saying "At class when someone smells a bad smell, the girls try to put it on me and give hints that I am the one that smells bad because I am fat and I need to shower a lot, and I don't know where they get this idea from that if you are fat then you smell bad."

3.3. Theme 3: Timing of external WBO

Participants spoke about experiencing WBO at all ages, including in their current lives. However, the experiences that hurt the participants most were those that occurred during childhood and adolescence. Many participants recalled stories from their childhood and school years with great clarity, including the pain felt at the time, and the ongoing shame and embarrassment resulting from the experiences. Participants also shared experiences of WBO in adulthood, and after marriage.

3.3.1. Childhood and teenage years

Most participants were bullied or teased because of their weight as children, and this escalated in teenage years, especially at school. Bullying was experienced from friends, classmates, other students, teachers, and in other settings such as at home, the gym, and other places. Dani vividly recalled her experiences, saying, "I was bullied a lot as a child, especially at school. People I don't know would come up to me and call me names like fatty or bear. They would literally point fingers at me in recess as I walked by them. I remember once being punched by boys because 'It felt like beating a pillow' they said, and this whole year at middle school they'd call me 'la vache qui rit' (translation: the laughing cow)." Likewise, Malak described the significant impact of early exposure to WBO, saying, "This affected me since childhood, I always put this idea in my mind that I am fat and this means that I am not like the other girls, and I can't be as beautiful as they are. The effect got even greater when I turned to a teenager. I entered the hospital several times, because of being obsessed with losing weight and looking as good as the other girls without caring about my health or anything else."

3.3.2. Adulthood

Exposure to external WBO continued into adulthood for most participants. Ongoing exposure was exasperating for some participants, indicating that they may have felt it would decline once they left their childhood years. As Arif said, "This weight bullying started from a young age, and it continued till this time. I am 32 years old, and I am still getting bullied and harassed in different settings? How long will this continue?" Mariam expressed her frustration with ongoing exposure to WBO from her parents, saying, "When we gather as a family to eat, my parents tell me what I am supposed to eat, even though I am a grown a** woman".

Several female participants spoke about the perception that a larger body is an impediment to getting married. Meem spoke about the dual pressures of men's preferences in a marriage partner, and families' desires to satisfy these, saying "I've also noticed that when it comes to marriage, men usually have a special request that they want to marry a slim and fit woman, with a nice body shape. Family also have a big role... As for my personal experience, my family used to tell me don't get fatter, no one wants to marry a fat woman, and usually hurtful words."

3.3.3. After marriage

All eight of the married participants experienced significant levels of bullying, teasing, and harassment from their spouses after marriage. This caused significant distress for the participants, which was evident as they described how they are treated differently by their spouse now in relation to their body weight. Maha Mahmoud explained, "I was in that perfect shape in the eyes of society before I get married, after the marriage and you having kids and all of that, my husband started to comment on my body and that I should be losing weight, and that I am not the girl he married with that awful body".

3.4. Theme 4: Sources of external WBO

Participants experienced external WBO from a variety of sources including family, friends, media, spouses, healthcare providers, teachers and professors, culture and society, and people at school, the gym, on public transport, in public places, and in the street.

3.4.1. Family

Most of the oppression based on body weight came from family members, particularly parents. Mothers and fathers put participants under constant pressure to restrict their eating and lose weight. Participants spoke about their parents mocking them because of their high weight or large size and comparing them unfavorably with their smaller sized siblings or others. Parents focused more on the participants' body weight than their achievements. As Dana recalled, "On the day of my master degree graduation, I was the top at my class, honor roll, and when I told my mum 'Are you proud of me?' she said 'Yes I am proud, but dear you were the biggest person on stage, you had the highest GPA and the highest weight', and that killed me." Participants also spoke about being subjected to horrendous shaming experiences by their parents, even as very young children. Dani explained, "I was 7? 8? My biological father would gather my siblings around me as I got up on the scale and would tell them 'Laugh at your sister' and then would sit me on the dinner table and not let me eat and everyone would call me 'cow'."

3.4.2. Friends

Friends were a prevalent source of external WBO, mostly in the form of hurtful comments and making fun of participants about their weight, often pretending they were joking. Participants spoke about the pain and embarrassment that this caused, especially when comments were made in front of others. Malak described one such situation, saying, "When my friends saw my elder sister, they were like 'She's so much prettier than you are and she looks younger than you. Be more like her and lose weight'." Malak described the significant hurt that experiences like this caused her. Amal described her perceptions about her relationship with friends, saying, "My friends tend to mock me and tease me because of my weight, and they abandoned me because of my weight, and they were only friends with me because they felt that I'm pathetic."

3.4.3. Media

More than half of the participants cited the role of the media in perpetuating WBO. This included mass media such as movies and magazines, and social media, particularly Instagram in perpetuating unrealistic ideals about beauty and attractiveness through the use of filters and editing, and through the widespread sharing of before and after weight loss images. Butterfly summed up many participants' beliefs about the presence of models on the platform, saying "Instagram it is full of thin bodies as models, and it is really rare to find a picture of a model with fat body. We have been exposed to role models as thin and slim so it kinda have sticked in our head that the preferred or more beautiful is the thin type of bodies."

Participants also highlighted the role of media advertising and the selective representation of people with different sized bodies. Gandi explained, "There are advertisements out there that would put someone that's slender in there as if they're running in the forest and it's so beautiful behind them and someone with a large body at home he's sitting, he's depressed he has a bag of chips." She went on to describe how these images create an association between an image and an emotion, and that such associations may lead some people to believe that this is how they should be. She explained, "I think that actually also affects people watching, so for example, if I would see that person with a larger body which is at home and just sitting and watching TV on their couch and eating chips and they look sad, (I would think) that's probably how I'm supposed to be. And not everyone recognize that's an image, they actually take it in and becomes part of their personality, and that's sad how powerful it (the media) is and how devastating at the same time. It (the media) should be used for good but it's being used for horrible things, really, really, it's so sad."

Representation of larger bodies in the media as the butt of jokes or as funny characters was also mentioned by participants as a source of negative stereotypes, making them sad and angry. As Sara 2 explained, "It really angers me, because they use their (larger)

bodies to make people laugh, instead of using their presence to tell people its normal. We have personalities, rather than seeing us as just a body."

Sara 2 then described the impact of the combination of sources of WBO on mental health and wellbeing, saying "If it wasn't for the media and pop culture, and how people were raised, and what they see every day of bullying of everything that's different on TV, they wouldn't project it on other people. By constantly joking around not knowing that it can literally put people into depression." Sara 2 went on to suggest this was a phenomenon confined to the Arabic media, and that "It's really different in American and European media." Dana also commented on the combined role of the media and the family, saying "Family makes it happen, and then media kind of amplifies it a lot by cartoons and having comics about it, and some drawings in the newspaper of fat people being made fun of. So actually, they create it."

3.4.4. Spouses

As mentioned in the thematic category about timing, all married participants reported their spouses as a source of external WBO. Participants described how their spouses tease or bully them and monitoring their food intake. As a result, they felt that they are not valued by their spouses and are neglected because of their higher weight. SA explained, "My husband is my number one bully. Can you imagine what it's like to live with a person who teases you and make fun of your body in every situation?" Um Abdulla described a recent situation, saying "Few days ago it was raining, so my husband was praying and saying, 'Dear god, please let my wife lose weight' as a joke, and I acted like I did not care but it felt bad." Meem described being called names and having her food intake closely monitored, saying "Even my husband teases me and calls me names such as 'dubba' (translation: fatty), cow, and seal. And even when I eat, he watches every single bite and tells me 'You eat a lot'."

3.4.5. Healthcare providers

Some participants experienced WBO from their healthcare providers. SA described a situation common to several participants, saying, "The first sentence that a doctor would say is your BMI is high, so you need to lose weight. But when you see the other health indicators of me you would see that they are very good and nothing is wrong with me, but when it comes to BMI classification the doctor himself make stereotype for people." Sara 3 described a similar experience of having every health issue attributed to her weight, saying, "I have regular visits to the hospital because of a certain health issue I suffer from. And each appointment I go to my doctor never forgets to mention how bad it is to be weighing this much, and that maybe all of what I'm in (my health issue) goes back to my weight." Arif described an experience of having his vital signs assessment conducted by a nurse, saying "When I was around 18 and I got on the scale one time at the hospital, the nurse shockingly told me 'Omg how could you carry all this weight in one body'."

Many participants described how being labeled as overw*ght or ob*se by their healthcare providers made them feel sad or depressed. Meem described the impact of being labeled ob*se by her doctor as making her "feel that I'm outcasted or rejected by the

society." She went on to describe her encounters with healthcare providers in relation to pregnancy and giving birth, saying "They always comment on my ob*se body. A doctor once told me that because I'm ob*se I won't be able to have a baby." The doctor's bold prediction, rooted in weight bias, was completely inaccurate as Meem went on to have several children.

Health checkups by school healthcare providers were another source of exposure to WBO due to the practice of weighing students and labeling them with the BMI classification. Sara 3 explained her feelings about this, saying "I really don't think these labels are okay because they allow for so much discrimination. Students would wanna compare their results, and for anyone who isn't in the area of 'ideal weight' or 'normal weight' it can be such a terrible thing. I don't see the need to do it or put a label on it."

Not all participants rejected outright the healthcare providers' use of BMI classifications, regarding them as objective and even helpful, whilst paradoxically also acknowledging the negative effect. As Kaltham explained, "If it (the BMI label) is from a nutritionist or a doctor or like trainer then I want to know their opinion… it's a pressure for me to lose weight and exercise and eat healthy food. Okay it would affect me in a negative way but like at the end of the day it would be an incentive way for me to lose weight, do workouts and eat healthy." Sarah also felt that being labeled with a BMI category would be both helpful and harmful, first saying that BMI categorization is a good thing because it helps people know where they are and what they need to do, and then highlighting the negative impact, saying that if she was labeled as ob*se, that "it will affect me, because I'll start to worry about my health."

3.4.6. Teachers and professors

Teachers and professors were a source of external WBO for some participants. Participants' memories of situations with teachers from school were still intense and vivid, despite many years having elapsed. One of the participants spoke about how, at the age of 45, she could still recall every detail of the weight stigma she experienced from her teacher, how she will never forget how it felt, and the effect it continues to have on her life. Participants associated their experiences of WBO from teachers with loss of productivity, high rates of absence, and low academic performance in school. Butterfly recalled, "I remember once in my school and during the class, I was asking my teacher whether I can turn on the AC (air conditioning) because I was feeling hot, and she replied back to me 'yeah of course you feel like it's hot because of the fat body' or something like 'the fat you are carrying'." The clarity with which Butterfly recalled this exchange with her teacher is indicative of the impact that even brief episodes of exposure to external WBO, particularly for children who are less well equipped to deal with them than adults. Some participants described their negative treatment at the hands of physical education teachers. Dana shared her feelings, saying, "Sports class was one of my least favorite classes. My physical education teacher gave us a test in a certain skill where you jump and flip, and on that day, it was my first menstrual day, so I wasn't able to perform. And when I told my teacher about this, she replied 'You can just say that you're ob*se and ob*se people cannot do that'."

As described above, one participant was prevented from fulfilling her lifelong dream to study psychology due to her professor's belief that people with larger bodies are "unhealthy" and "unhealthy" people cannot be psychologists.

3.4.7. Culture and society

Arabic culture and society were highlighted as significant sources of WBO, with participants noting that this is contrary to the perception outside the Arab world that Arabic culture is more accepting of size diversity. Participants expressed the belief that WBO is regarded as completely acceptable and as a result is widespread in Arabic society. Participants noted that Arabic culture now mirrors western culture, with thin bodies indicating healthiness and large bodies indicating unhealthiness. Having a large body size is widely seen as sign of infertility in the Arab region. Participant also talked about the intergenerational effects, thereby challenging another misconception that WBO is a recent phenomenon in Arabic society. Sara 3 noted, "Our culture and society promotes the idea of big bodies being embarrassing, a problem, and a bad unacceptable thing." Dana expressed her frustration with the role of culture saying, "What I hate the most about the Arabic culture, is that it always puts the blame on the girl's weight when it comes to everything, whether if she can't get pregnant or not yet married." Battuta shared her belief that, "A perfect slim body is one of the most cherished ideologies in our Arabic culture, it's like Arab people are programmed to the idea that there is only one perfect body size."

3.4.8. Others

Sources of WBO were not limited to family members, friends, healthcare providers, or teachers. Participants experienced WBO from other people including people at the gym, school, on public transport, and in streets and other public places. Sara 2 described a situation where strangers felt entitled to dictate her choice of activity, explaining, "Some ladies at the gym were looking at me in a weird way and they later came to tell me that I should do something about myself. I shouldn't be swimming because I shouldn't be wearing a swimming suit. I should go for a walk or something rather than swim, because no one wants to be looking at my body." Sara 3 described a similar situation in which a stranger felt entitled to make unsolicited comments on her body, saying, "I was once at a conference, and I was wearing a little high waisted pants in which I guess the 'flaws' of my figure were apparent, and this guy thought it would be okay to poke fun at my figure in the middle of everyone and he made a comment about how I looked 'a little pregnant'."

3.5. Theme 5: Extent of external WBO

3.5.1. Normative

Although only a small number of participants spoke about the culture as a source of WBO, most participants considered WBO to be an everyday phenomenon in Arab culture. Participants believed that negative attitudes and practices toward people with larger bodies are so extensive and accepted that external WBO is regarded as normative within the Arabic culture. Sara 3 described how

extensive this was for her, saying, "I was bullied for being fat in every situation and in every outfit and every celebration, Eid, weddings, etc." Butterfly commented on the normative and intergenerational nature of external WBO, explaining, "It is has become like a normal thing in the society in our culture, each generation teaches the next one this idea. We grew up knowing that fat bodies are not as acceptable and even that they are shameful, and we can't be in a large size".

3.6. Theme 6: Impact of internalized WBO and exposure to external WBO

Experiencing WBO resulted in negative mental, psychological, emotional, social, and physical consequences such as low self-esteem, self-isolation, depression and anxiety, restrictive eating or dieting, eating disorders, thinking about or proceeding with bariatric surgery, and suicidal ideation or attempt.

3.6.1. Low self-esteem

Almost all participants identified low self-esteem as a consequence of WBO. For participants, low self-esteem encompassed lack of confidence, negative body image, lack of love toward oneself, feeling unworthy and not good enough. For Battuta, "It affected my self-esteem. I started to hate my body and not accepting it. I'm not always at ease when I meet new people and I avoid meeting new people." Amal explained, "I used to cry, and I hate doing my daily activities. It affected my productivity and sometimes it reached a point where I hurt myself. For example, I used to see myself in the mirror and say ugly! I hurt myself on purpose and I intentionally say that to myself. I really had low self-esteem."

3.6.2. Self-isolation

As Battuta describe above, low self-esteem resulted in self-isolation. This was common amongst most participants, with exposure to WBO resulting in a range of negative social consequences. Participants spoke about how they actively avoid going out, taking group pictures, being around people or being socially engaged, especially on special occasions or at gatherings of family and friends. Aysha explained, "I became a person who don't want to be engaged in the community. I used to feel really shy and embarrassed, so I isolated myself from people." Hala described a similar strategy, saying, "I isolated myself. I used to not want to be friends with anyone. I preferred to be alone to avoid people's comment. I used to hate going to occasions, and if I ever go, I used to stay in abaya because I hated how clothes look on me." SA explained the impact on her, saying, "I hated going out to see people, I hated gathering with people. I don't approach people and talk to them because of my weight. So, it affected me socially a lot."

3.6.3. Depression and anxiety

Participants strongly believed that WBO resulted in mental health conditions, including depression and anxiety requiring professional treatment. Dani described the impact for her, saying,

"I suffered from depression for years and I used to be on antidepressants, till now I have depressive episodes from time to time. You hate your body, you hate yourself, you hate them as well. The psychological effect that this led to is much more serious than the weight itself." Sara 2 also highlighted that these effects were because of exposure to WBO, explaining, "I would just say that I do not suffer from any health issues because of my weight. The only issues I have are on my mental health, anxiety and depression and these are not because of my weight they are because of how people view my weight and body".

3.6.4. Restriction and dieting

Two-thirds of the participants spoke about their repeated attempts to change their body weight and thereby escape WBO through restricting their eating or embarking on diets. Many of these diets were deficient in nutrients, and unsustainable over a sustained period. Battuta recalled one such diet, saying, "I remember one time, I tried the 'watermelon diet', so it basically tells you to eat nothing but a watermelon for a certain time, and I experienced horrible weight and hair loss at that time." Zayed discussed the range of diets he had attempted, and the damaging consequences for his relationship with food, saying "I tried every weight loss method that can come across your mind. I reached a point where I fear food and count calories for every single food item I consume."

3.6.5. Eating disorders

Almost half of the participants described how exposure to WBO led to the development of disordered eating behaviors and eating disorders, including self-induced vomiting, binge eating, emotional eating, and bulimia. Malak described her situation, saying, "I felt like I craved food more and more till it turned to binge eating. I started to eat without stopping, till I slowly reached my previous weight, and that made me commit a very awful thing, which was eating and then putting my finger in my mouth to induce vomiting, and this habit stayed with me for almost a week and then my body could not handle it anymore, so I went to the hospital." Dani described how she developed an eating disorder as a child, saying, "I felt like this is always something that I had to focus on. I can't remember a single time period in my life that my weight obsession was out of the picture. It led to me forming bulimia at the age of 12."

3.6.6. Bariatric surgery

Over half of the participants considered or had undergone bariatric surgery because of exposure to WBO, including sleeve gastrectomy, adjustable gastric band, and gastric balloon. Although this surgery has a high level of risk, it was seen as an acceptable and almost routine procedure to reduce exposure to WBO. As K stated, "Qatari society has one preference to the point that anyone with extra kilos will be told 'there are surgeries to cut some weight, go have one'." Dana talked about the process that led up to her decision, explaining, "I said 'Well I'm sick and suffering, people still see that I'm fat, they don't see my achievement, so you know what, let me do this as a last resort. I'll do the gastric sleeve operation and see what happens'."

3.6.7. Suicidal ideation or attempt

One of the most serious impacts of experiencing WBO was thinking about or attempting suicide. Almost half of the participants expressed wanting to end their lives at some point to relieve their suffering from exposure to WBO. Whilst recalling these feelings, participants demonstrated deep sorrow, and some were crying while sharing these experiences. Hala shared her experience, saying, "I had depression from time to time and I was always thinking of a way of dying, and I knew that if I confessed this to my family, they will not take it seriously. So I was lonely, and I attempted suicide using pills and went to hospital. At that time, I had my son who was 8 years old." Butterfly shared her story, saying, "I couldn't take it any further, I even thought of ending my life instead of living this every single day."

4. Discussion

This study explored experiences of weight-based oppression experiences among 29 students, staff, and faculty at Qatar University. WBO was perceived to be so common that it was regarded as normative and intergenerational. Experiences of WBO included teasing, harassment, stigmatization, and discrimination based on body weight from family, friends, spouses, healthcare providers, teachers, and other people. The media and Arabic culture were also regarded as important sources of WBO. Experiences of WBO occurred throughout life, but those that occurred in childhood and adolescence were particularly painful. These experiences had significant and lasting negative psychological, emotional, social, and physical consequences for participants' health and wellbeing. Participants experienced negative internalized feelings, beliefs, and attitudes about their own body weight such as low self-esteem, embarrassment, shame, body dissatisfaction, sadness, and worthlessness. Exposure to WBO resulted in social isolation, depression and anxiety, food restriction, dieting, disordered eating, and eating disorders. Some participants had thought about or tried bariatric surgery or suicide to escape WBO.

This is the first study to qualitatively explore experiences of weight-based oppression in Qatar and the Arab region, and in many respects, the study findings are comparable to those from studies in other regions of the world. In this study, participants perceived WBO to be highly prevalent in Qatar and the Arab region. In fact, WBO is perceived as being so common that it is regarded as normative and completely acceptable. This perception is consistent with studies elsewhere that have demonstrated the high prevalence of various forms of WBO such as teasing, bullying, and discrimination in countries in the Global North (69). Further population-based studies are needed to determine if the actual prevalence of WBO is as high in the Arab region as perceived.

Participants experienced WBO at all ages, but the impact of exposure during childhood and adolescence was particularly significant. Sources of WBO at a young age included parents, friends, and teachers. Young people with higher body weight are vulnerable to weight-based bullying, harassment, stigmatization and teasing in school settings (3, 70). Weight-based bullying is one of the most common types of bullying that children and youth face (71–73). Children and adolescents are mostly frequently

exposed to WBO from family, friends, peers, and teachers. The memories of these exposures to WBO for participants in our study were very strong, and many years later evoked significant sadness. Although participants recalled many experiences WBO at other times in their lives, it was these childhood exposures that they seemed to be particularly damaging. Children are less equipped to deal with exposure to hurtful comments or behaviors, and if the perpetrators of those behaviors are people in positions of trust and authority, then the capacity of young people to reject these behaviors and resist the internalization of the messages is limited. Particular attention should therefore be paid to eliminating WBO in the structures and systems that most impact on young people, such as the family and school environments.

In adulthood, sources of WBO for our participants included family, friends, professors, healthcare providers, and for married participants, spouses. This is consistent with findings from other studies demonstrating the extent of this issue. WBO from family was the most commonly reported exposure, and participants relayed painful examples of their treatment at the hands of their parents and siblings. All married participants shared devastating experiences of WBO from their spouses. WBO from family can be the most painful experience as it comes from people who supposedly love and protect you (74). With respect to healthcare providers, our participants spoke about the healthcare inequalities they have experienced from doctors and nurses, which reflects a significant body of literature demonstrating high levels of WBO from these professions. A recent systematic review confirmed widespread weight bias in a range of healthcare providers (75).

Interestingly, only four of our participants identified Arabic culture and society as a source of WBO, however almost all described WBO as being universal within Arabic culture. This differential may reflect the widespread belief that WBO is totally "normal", and that is it not specific to Arabic culture. Various studies have investigated aspects of WBO such as weight bias internalization, exposure to weight stigmatizing experiences, and weight discrimination in the Global North, with most of these studies conducted in the USA (76). Investigations in the Global South and in the Arab region in particular, are limited. More broadly, the cultural imperialism of the Global North has seen the adoption of "western" appearance ideals, particularly the thin/non-fat ideals for all genders. Rates of eating disorders have rapidly increased in the Global South (77) and identification with western culture is associated higher levels of eating disorder symptomatology for Arabic women (78). The role of mass media and social media in this messaging was well recognized by our participants, consistent with literature demonstrating strong links between exposure to media and WBO in western cultural contexts (79).

Turning to the consequences of WBO, our study found that exposure to WBO results in significant psychological distress, including shame, embarrassment, feelings of worthlessness, depression, and anxiety. Many participants demonstrated significant levels of internalized WBO, indicating their belief that there is something inherently wrong with their larger bodies. Some participants also identified that their psychological distress was because of their unfair treatment based on their body weight. The strong relationship between psychological distress and WBO is consistent with many other studies. A recent systematic review (80) and meta-analysis (81) established that exposure to WBO is consistently associated with depression.

One of the most common behavioral consequences of exposure to WBO is changes to eating patterns. In our study we found that participants reported engaging in food restriction and dieting in response to internalized and external WBO. For many, the adoption of food restriction or dieting was strongly encouraged or even demanded by parents or family members. However, there is now a significant body of research that demonstrates the failure of dieting to sustainably reduce body size (82, 83), and subsequent weight regain is often attributed to the failure of the dieter, rather than a natural physiological response to dieting, furthering the shame that people feel about their bodies. For some participants in our study, restriction and dieting escalated into eating disorders, and others discussed developing eating disorders as a direct result of exposure to WBO. A recent scoping review revealed that rates of eating disorders in the Arab region averaged 31% with some studies detecting rates up to 75% in specific samples (84). The relationship between internalized WBO, exposure to WBO, disordered eating, and eating disorders is well documented (85, 86). Within the Arab region, studies on males in Kuwait (87) and females in the United Arab Emirates (14) have found associations between internalized or external WBO and eating disorder symptomatology. This is consistent with other studies that have demonstrated that weight-based stigmatization is associated with a range of behavioral consequences, including binge eating disorder (88). Weight-based teasing in adolescence prospectively predicts binge eating up to 5 years later (89, 90).

Our finding that exposure to WBO resulted in suicidal ideation and suicide attempts adds to the existing literature about the severe consequences of WBO. WBO is associated with higher levels of suicidal ideation in adults, with the effect mediated by depression (91). Likewise for young people (92) and children (93), the most serious emotional consequence of WBO is the increased risk of thinking about and attempting suicide. Adolescents who are teased about their body weight are two to three times more likely to have suicidal thoughts than those not subjected to such teasing (94). In this study, around half of the participants had suicidal ideation or suicide attempts. This is consistent with the findings of a study that found over 50% of females and 13% of males who were exposed to WBO from their family and friends considered attempting suicide (9). This is hugely concerning, and further research is urgently required to establish the prevalence of such consequences in Qatar and the Arab region.

The decision to undertake bariatric surgery such as sleeve gastrectomy, adjustable gastric band, and gastric balloon was another consequence of being exposed to WBO, and more than half of the participants in this study were considering such surgery or had already had it. This was particularly the case for participants who expressed feelings of sadness and depression, or that had disordered eating or eating disorders. This finding was expected as eating disorders, anxiety, and depression are prevalent in candidates for bariatric surgery (95), with depression and eating disorders more prevalent in bariatric surgery candidates than in the general population (96). Undergoing bariatric surgery also increases the subsequent risk of self-harm, suicidal ideation, suicide

attempts, and suicide (97, 98). Making the choice to undergo bariatric surgery to escape WBO and its psychological sequelae is understandable, given the extremely low efficacy of other weight loss strategies, the internalization of negative beliefs and attitudes about higher weight, and ongoing exposure to the stress of WBO. Bariatric surgery is widely practiced in Qatar, and although no official government statistics are available, news reports stated that in 2014, around 2,000 surgeries were performed in a population at the time of 2.2 million people (99), with 70% of recipients being women. This was compared to the rate in Japan where 200 bariatric surgeries were performed in a population of 127 million. In 2022, the government health service reported that it performs 800–1,000 surgeries per year (100). The normative nature of WBO combined with the normalization of bariatric surgery creates the perfect storm to drive up rates of bariatric surgery.

This study explored WBO using the RLCHPM as a theoretical foundation. Exploring and understanding a health issue is part of the community assessment phase, which is the first phase in the health promotion process. By conducting regular critical reflection (represented by the stems of the plant in the RLCHPM) on the values and principles in the RLCHPM (represented by the tuber and roots), we ensured that the study explored WBO holistically and revealed a range of physical, mental, and social consequences of WBO (represented by the lotus flower pod). In addition, the RLCHPM guided us to examine the characteristics of people (represented by the stamens of the lotus flower) and different types of environments (represented by the first petal layer of the flower) that lead to WBO, and how these factors connect and operate at multiple levels from the individual level to the family, community, organization, and society levels. Using the RLCHPM therefore ensured that we took a socio-ecological or systems approach to the exploration of WBO (a value and principle represented by the tuber and roots). Finally, critically reflecting on the potential for harm throughout the research process helped us to minimize potential harms (a value and principle represented by the tuber and roots).

The findings from this study indicate that WBO operates at the intrapersonal, interpersonal, family, community, society, and population levels, and has significant negative psychological, emotional, behavioral, social, and physical consequences resulting in poor health outcomes. None of the participants indicated that WBO resulted in improvements in their health and wellbeing. This is contrary to the commonly held belief, also expressed by some public health writers, that greater exposure to WBO might give people with higher body weight the "motivation" to improve their (assumed) poor health and change their (assumed) poor behaviors (101). This study provides evidence that such an approach would not only be unsuccessful at such "motivation", but would perpetuate and extend the harm caused by WBO.

4.1. Strengths and limitations

There are several strengths of this qualitative exploratory study. It provides the first insight into the lived experiences of WBO of people in the Arab region. The study provides a holistic view of the phenomenon with exploration of participants' experiences of WBO from many different perspectives and at multiple inter-related levels. As a method for exploring a sensitive topic, using semi-structured interviews allowed participants to express themselves in their own words, and share their experiences in as much detail as they wished. In-person and WhatsApp call interviews also allowed for the observation of the body language and speaking tone of participants, and to connect their emotions to their words. Although the requirement to switch to online interview administration was initially regarded as a limitation potentially impacting on the quality and quantity of data, it was apparent that this may have inadvertently had a positive impact. We noticed that participants who used text or voice notes to complete their interviews provided significantly longer and more in-depth responses to the interview questions than many of those interviewed in person or *via* a WhatsApp video or audio call. This observation warrants further research to validate if using text and/or voice note exchanges provide the same rigor and quality as other more established interview administration methods.

Despite the important contributions of this study's findings, limitations must be considered. A limitation of the single face-to-face interview is that there was little time to build trust and rapport with participants. Because the interview addressed a sensitive issue and one that involves significant pain for many participants, the limited time may have inhibited their responses. A second limitation was the discrepancy between the interviewers and participants' body sizes. Neither of the interviewers is fat, and this may have affected the responses provided by participants in the in-person interviews. This may not have impacted on the interviews conducted *via* text or voice notes. A third limitation of the study is that the findings were generated from a relatively small group of people within the Qatar University community. Further studies are required to determine if these experiences are similar or different to those of people in the broader community in Qatar and the Middle East, and the extent of this issue in the Arab region. Finally, the findings from this study are particular to the participants and the interpretation of the researchers.

5. Conclusion

WBO in the Arab region is an important and unrecognized public health issue. This study, the first of its kind in the Arab region, demonstrated that WBO is so common that it is regarded as normative. For participants in our study, WBO had significant negative implications for their physical, mental, and social health and wellbeing. Further research is required to determine the nature and extent of WBO within the broader community and other countries in the Arab region. In addition, research must be conducted to develop and test the effectiveness of critical health promotion strategies to reduce internalized and external WBO in all sectors. Critical health promotion involves addressing systemic and structural sources of oppression (52) using a portfolio of strategies encompassing building healthy public policy, creating supporting environments, and strengthening community action as priority strategies. Of particular urgency is the need to develop critical health promotion programs addressing social and cultural systems and structures to reduce teasing, bullying, and negative experiences related to body weight in childhood. This will require working with governments, social media, corporations,

parents, teachers, healthcare professionals, young people, and the community to develop critical health promotion programs that reduce children's exposure to toxic messages about their bodies and weight-related practices that are harmful to them.

Data availability statement

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

Ethics statement

This study involving human participants was reviewed and approved by Qatar University Institutional Review Board. The participants provided their written informed consent to participate in this study.

Author contributions

LO'H conceived and designed the study. BAA and BAS collected the data. All authors analyzed the data, wrote the manuscript, contributed to manuscript revision, read, and approved the submitted version.

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Conflict of interest

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

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpubh.2023.1015181/full#supplementary-material

References

1. Browne NT. Weight bias, stigmatization, and bullying of obese youth. *Bariatr Nurs Surg Patient Care.* (2012) 7:107–15. doi: 10.1089/bar.2012.9972

2. Puhl RM, Latner JD, O'Brien K, Luedicke J, Danielsdottir S, Forhan M. A multinational examination of weight bias: predictors of anti-fat attitudes across four countries. *Int J Obes.* (2015) 39:1166–73. doi: 10.1038/ijo.2015.32

3. Bucchianeri MM, Eisenberg ME, Neumark-Sztainer D. Weightism, racism, classism, and sexism: shared forms of harassment in adolescents. *J Adolescent Health.* (2013) 53:47–53. doi: 10.1016/j.jadohealth.2013.01.006

4. Puhl RM, Himmelstein MS, Watson RJ. Weight-based victimization among sexual and gender minority adolescents: findings from a diverse national sample. *Pediatr Obes.* (2019) 14:e12514. doi: 10.1111/ijpo.12514

5. Dutton GR, Lewis TT, Durant N, Halanych J, Kiefe CI, Sidney S, et al. Perceived weight discrimination in the CARDIA study: differences by race, sex, and weight status. *Obesity.* (2014) 22:530–6. doi: 10.1002/oby.20438

6. Bucchianeri MM, Gower AL, McMorris BJ, Eisenberg ME. Youth experiences with multiple types of prejudice-based harassment. *J Adolesc.* (2016) 51:68–75. doi: 10.1016/j.adolescence.2016.05.012

7. Alberga AS, Russell-Mayhew S, von Ranson KM, McLaren L. Weight bias: a call to action. *J Eat Disord.* (2016) 4:34. doi: 10.1186/s40337-016-0112-4

8. Salas XR, Forhan M, Caulfield T, Sharma AM, Raine KD. Addressing internalized weight bias and changing damaged social identities for people living with obesity. *Front Psychol.* (2019) 10:1409. doi: 10.3389/fpsyg.2019.01409

9. Major B, Dovidio JF, Link BG. *The Oxford Handbook of Stigma, Discrimination, and Health. Oxford Library of Psychology.* New York: Oxford University Press (2018). p. xx, 556.

10. Madowitz J, Knatz S, Maginot T, Crow SJ, Boutelle KN. Teasing, depression and unhealthy weight control behaviour in obese children. *Pediatr Obes.* (2012) 7:446–52. doi: 10.1111/j.2047-6310.2012.00078.x

11. Neumark-Sztainer DR, Wall MM, Haines JI, Story MT, Sherwood NE, van den Berg PA. Shared risk and protective factors for overweight and disordered eating in adolescents. *Am J Prev Med.* (2007) 33:359–69.e3. doi: 10.1016/j.amepre.2007.07.031

12. Dahill LM, Morrison NMV, Mannan H, Mitchison D, Touyz S, Bussey K, et al. Exploring associations between positive and negative valanced parental comments about adolescents' bodies and eating and eating problems: a community study. *J Eat Disord.* (2022) 10:1–5. doi: 10.1186/s40337-022-00561-6

13. Dahill LM, Touyz S, Morrison NMV, Hay P. Parental appearance teasing in adolescence and associations with eating problems: a systematic review. *BMC Public Health.* (2021) 21:1–3. doi: 10.1186/s12889-021-10416-5

14. O'Hara L, Tahboub-Schulte S, Thomas J. Weight-related teasing and internalized weight stigma predict abnormal eating attitudes and behaviours in Emirati female university students. *Appetite.* (2016) 102:44–50. doi: 10.1016/j.appet.2016.01.019

15. Latner JD, Barile JP, Durso LE, O'Brien KS. Weight and health-related quality of life: the moderating role of weight discrimination and internalized weight bias. *Eat Behav.* (2014) 15:586–90. doi: 10.1016/j.eatbeh.2014.08.014

16. Pila E, Sabiston CM, Taylor VH, Arbour-Nicitopoulos K. "The weight is even worse than the cancer": exploring weight preoccupation in women treated for breast cancer. *Qual Health Res.* (2018) 28:1354–65. doi: 10.1177/1049732318770403

17. Schwartz MB, Vartanian LR, Nosek BA, Brownell KD. The influence of one's own body weight on implicit and explicit anti-fat bias. *Obesity.* (2006) 14:440–7. doi: 10.1038/oby.2006.58

18. Friedman KE, Ashmore JA, Applegate KL. recent experiences of weight-based stigmatization in a weight loss surgery population: psychological and behavioral correlates. *Obesity.* (2008) 16:S69–74. doi: 10.1038/oby.2008.457

19. Puhl RM, Heuer CA. Obesity stigma: important considerations for public health. *Am J Public Health.* (2010) 100:1019. doi: 10.2105/AJPH.2009.159491

20. Puhl RM, Moss-Racusin CA, Schwartz MB. Internalization of weight bias: implications for binge eating and emotional well-being. *Obesity.* (2007) 15:19–23. doi: 10.1038/oby.2007.521

21. Schvey NA, Puhl RM, Brownell KD. The impact of weight stigma on caloric consumption. *Obesity.* (2011) 19:1957–62. doi: 10.1038/oby.2011.204

22. Essayli JH, Murakami JM, Wilson RE, Latner JD. the impact of weight labels on body image, internalized weight stigma, affect, perceived health, and intended weight loss behaviors in normal-weight and overweight college women. *Am J Health Promot.* (2017) 31:484–90. doi: 10.1177/0890117116661982

23. Davison KK, Schmalz DL, Young LM, Birch LL. Overweight girls who internalize fat stereotypes report low psychosocial well-being. *Obesity.* (2008) 16:S30–8. doi: 10.1038/oby.2008.451

24. Savoy S, Almeida L, Boxer P. The relation of weight stigmatization to psychological adjustment. *J Appl Soc Psychol.* (2012) 42:2285–308. doi: 10.1111/j.1559-1816.2012.00940.x

25. Phelan SM, Burgess DJ, Puhl R, Dyrbye LN, Dovidio JF, Yeazel M, et al. The adverse effect of weight stigma on the well-being of medical students with overweight or obesity: findings from a national survey. *J Gen Intern Med.* (2015) 30:1251–8. doi: 10.1007/s11606-015-3266-x

26. Griffiths LJ, Page AS. The impact of weight-related victimization on peer relationships: the female adolescent perspective. *Obesity.* (2008) 16:S39–45. doi: 10.1038/oby.2008.449

27. Graham D, Edwards A. The psychological burden of obesity: the potential harmful impact of health promotion and education programmes targeting obese individuals. *Int J Health Promot Educ.* (2013) 51:124–33. doi: 10.1080/14635240.2012.750504

28. Pearl RL, Dovidio JF, Puhl RM, Brownell KD. Exposure to weight-stigmatizing media: effects on exercise intentions, motivation, and behavior. *J Health Commun.* (2015) 20:1004–13. doi: 10.1080/10810730.2015.1018601

29. Vartanian LR, Smyth JM. Primum non nocere: obesity stigma and public health. *J Bioeth Inq.* (2013) 10:49–57. doi: 10.1007/s11673-012-9412-9

30. Storch EA, Milsom VA, Debraganza N, Lewin AB, Geffken GR, Silverstein JH. Peer victimization, psychosocial adjustment, and physical activity in overweight and at-risk-for-overweight youth. *J Pediatr Psychol.* (2007) 32:80–9. doi: 10.1093/jpepsy/jsj113

31. Neumark-Sztainer D, Falkner N, Story M, Perry C, Hannan PJ, Mulert S. Weight-teasing among adolescents: correlations with weight status and disordered eating behaviors. *Int J Obes.* (2002) 26:123–31. doi: 10.1038/sj.ijo.0801853

32. Mustillo SA, Budd K, Hendrix K. Obesity, labeling, and psychological distress in late-childhood and adolescent black and white girls: the distal effects of stigma. *Soc Psychol Q.* (2013) 76:268–89. doi: 10.1177/0190272513495883

33. Unger ES, Kawachi I, Milliren CE, Sonneville KR, Thurston IB, Gooding HC, et al. Protective misperception? Prospective study of weight self-perception and blood pressure in adolescents with overweight and obesity. *J Adolesc Health.* (2017) 60:680–7. doi: 10.1016/j.jadohealth.2016.12.017

34. Rosenthal L, Earnshaw VA, Carroll-Scott A, Henderson KE, Peters SM, McCaslin C, et al. Weight- and race-based bullying: health associations among urban adolescents. *J Health Psychol.* (2013) 20:401–12. doi: 10.1177/1359105313502567

35. Wirth MD, Blake CE, Hébert JR, Sui X, Blair SN. Chronic weight dissatisfaction predicts type 2 diabetes risk: Aerobic Center Longitudinal Study. *Health Psychol.* (2014) 33:912–9. doi: 10.1037/hea0000058

36. Wirth MD, Blake CE, Hébert JR, Sui X, Blair SN. Metabolic syndrome and discrepancy between actual and self-identified good weight: Aerobics Center Longitudinal Study. *Body Image.* (2015) 13:28–32. doi: 10.1016/j.bodyim.2014.11.003

37. Pearl RL, Wadden TA, Hopkins CM, Shaw JA, Hayes MR, Bakizada ZM, et al. Association between weight bias internalization and metabolic syndrome among treatment-seeking individuals with obesity. *Obesity.* (2017) 25:317–22. doi: 10.1002/oby.21716

38. Vadiveloo M, Mattei J. Perceived weight discrimination and 10-year risk of allostatic load among US adults. *Ann Behav Med.* (2017) 51:1–7. doi: 10.1007/s12160-016-9831-7

39. Schvey NA, Puhl RM, Brownell KD. The stress of stigma: exploring the effect of weight stigma on cortisol reactivity. *Psychosom Med.* (2014) 76:1–7. doi: 10.1097/PSY.0000000000000031

40. Tomiyama AJ, Epel ES, McClatchey TM, Poelke G, Kemeny ME, McCoy SK, et al. Associations of weight stigma with cortisol and oxidative stress independent of adiposity. *Health Psychol.* (2014) 33:862–7. doi: 10.1037/hea0000107

41. El Ansari W, Berg-Beckhoff G. Association of health status and health behaviors with weight satisfaction vs. body image concern: analysis of 5888 undergraduates in Egypt, Palestine, and Finland. *Nutrients.* (2019) 11:2860. doi: 10.3390/nu11122860

42. Fatima W, Ahmad LM. Prevalence of disordered eating attitudes among adolescent girls in Arar City, Kingdom of Saudi Arabia. *Health Psychol Res.* (2018) 6:30–35. doi: 10.4081/hpr.2018.7444

43. Althani M, Khaled S. "Toxic pleasures": a study of eating out behavior in Arab female university students and its associations with psychological distress and disordered eating. *Eat Behav.* (2018) 31:125–30. doi: 10.1016/j.eatbeh.2018.08.008

44. Qutteina Y, Nasrallah C, Kimmel L, Khaled SM. Relationship between social media use and disordered eating behavior among female university students in Qatar. *J Health Soc Sci.* (2019) 4:59–72. doi: 10.19204/2019/rltn7

45. Thomas J, O'Hara L, Tahboub-Schulte S, Grey I, Chowdhury N. Holy Anorexia: eating disorders symptomatology and religiosity among Muslim women in the United Arab Emirates. *Psychiatry Res.* (2017) 260:495–9. doi: 10.1016/j.psychres.2017.11.082

46. Fatima W, Fatima R, Anwar NS. Disordered eating attitude and body dissatisfaction among adolescents of Arab countries: a review. *Asian J Biol Sci.* (2019) 12:373–9. doi: 10.3923/ajbs.2019.373.379

47. Nasser M. Eating disorders across cultures. *Psychiatry.* (2009) 8:347–50. doi: 10.1016/j.mppsy.2009.06.009

48. Gordon RA. Eating disorders East and West: a culture-bound syndrome unbound. In: Nasser M, Katzman MA, Gordon RA, editors. *Eating Disorders and Cultures in Transition.* East Sussex: Brunner-Routledge (2001). p. 1–16.

49. Crotty M. The Foundations of Social Research: Meaning and Perspective in the Research Process. 1 ed. Crows Nest: Allen and Unwin (1998).

50. Tong A, Sainsbury P, Craig J. Consolidated criteria for reporting qualitative research (COREQ): a 32-item checklist for interviews and focus groups. *Int J Qual Health Care.* (2007) 19:349–57. doi: 10.1093/intqhc/mzm042

51. Hamill H. *Interview Methodology.* (2019). Available online at: https://www.oxfordbibliographies.com/display/document/obo-9780199756384/obo-9780199756384-0105.xml (accessed February 4, 2023).

52. O'Hara L, Taylor J. A critical health promotion research approach using the Red Lotus Critical Health Promotion Model. In: Potvin L, Jourdan D, editors. *Global Handbook of Health Promotion Research.* Cham: Springer (2022). p. 541–66.

53. Gregg J, O'Hara L. The Red Lotus Health Promotion Model: a new model for holistic, ecological, salutogenic health promotion practice. *Health Promot J Aust.* (2007) 18:12–9. doi: 10.1071/HE07012

54. Taylor J, O'Hara L, Talbot L, Verrinder G. *Promoting Health: The Primary Health Care Approach.* 7 ed. Chatswood, NSW: Elsevier Australia (2021).

55. Jamieson MK, Govaart GH, Pownall M. *Reflexivity in Quantitative Research: A Rationale and Beginner's Guide.* (2022). Available online at: https://psyarxiv.com/xvrhm (accessed August 12, 2022).

56. Hennink M, Kaiser BN. Sample sizes for saturation in qualitative research: a systematic review of empirical tests. *Soc Sci Med.* (2022) 292:114523. doi: 10.1016/j.socscimed.2021.114523

57. Morse JM. The significance of saturation. *Qual Health Res.* (1995) 5:147–9. doi: 10.1177/104973239500500201

58. Wong L. Data analysis in qualitative research: a brief guide to using NVivo. *Malaysian Family Physician.* (2008) 3:14–20.

59. Aphramor L. Reframing Health Ethics to Support Liberation. *Medium.* (2020). Available online at: https://medium.com/@lucy.aphramor/reframing-health-ethics-to-support-liberation-11063da4e46 (accessed May 12, 2020).

60. Daly M, Robinson E, Sutin AR. Does knowing hurt? Perceiving oneself as overweight predicts future physical health and well-being. *Psychol Sci.* (2017) 2017:1–10. doi: 10.1177/0956797617696311

61. Hunger JM, Tomiyama AJ. Weight labeling and obesity: a longitudinal study of girls aged 10 to 19 years. *JAMA Pediatr.* (2014) 168:579–80. doi: 10.1001/jamapediatrics.2014.122

62. Meadows A, Daníelsdóttir S. What's in a word? On weight stigma and terminology. *Front Psychol.* (2016) 7:1527. doi: 10.3389/fpsyg.2016.01527

63. Almond D, Lee A, Schwartz AE. Impacts of classifying New York City students as overweight. *Proc Natl Acad Sci USA.* (2016) 113:3488–3491. doi: 10.1073/pnas.1518443113

64. Mercedes M. *Expertise is Not Social Justice: Reflecting on the "Ob*sity Epidemic".* (2020). Available online at: https://marquisele.medium.com/expertise-is-not-social-justice-reflecting-on-the-ob-sity-epidemic-7c2c87354ddf (accessed September 3, 2020).

65. @your_body_is_good. "Obesity" Is a Slur. I Stand by That. It Has Oppression and Judgment Built Into It. (2020). Available online at: https://www.instagram.com/p/CAbP57WpNo1/?hl=en (accessed May 21, 2020).

66. Larmie A. *The Fat Doctor.* (n.d.). Available online at: https://www.fatdoctor.co.uk/

67. Tylka TL, Annunziato RA, Burgard D, Daníelsdóttir S, Shuman E, Davis C, et al. The weight-inclusive versus weight-normative approach to health: evaluating the evidence for prioritizing well-being over weight loss. *J Obes.* (2014) 18:983495. doi: 10.1155/2014/983495

68. Perlman M. *AP Updates Guidance on Mentions of Race, Accent Marks, and More.* (2019). Available online at: https://www.cjr.org/language_corner/ap-race-accent-marks-sic.php (accessed April 8, 2019).

69. Puhl RM, Lessard LM, Pearl RL, Himmelstein MS, Foster GD. International comparisons of weight stigma: addressing a void in the field. *Int J Obes.* (2021) 45:1976–85. doi: 10.1038/s41366-021-00860-z

70. Puhl RM, Peterson JL, Luedicke J. Weight-based victimization: bullying experiences of weight loss treatment–seeking youth. *Pediatrics.* (2013) 131:e1–9. doi: 10.1542/peds.2012-1106

71. Bradshaw CP, Waasdorp TE, O'Brennan LM, Gulemetova M. Teachers' and education support professionals' perspectives on bullying and prevention: findings from a national education association study. *School Psych Rev.* (2013) 42:280–97. doi: 10.1080/02796015.2013.12087474

72. Puhl RM, Luedicke J, Heuer CA. Weight-based victimization toward overweight adolescents: observations and reactions of peers. *J School Health.* (2011) 81:696–703. doi: 10.1111/j.1746-1561.2011.00646.x

73. Puhl RM, Luedicke J, DePierre JA. Parental concerns about weight-based victimization in youth. *Childhood Obesity.* (2013) 9:540–8. doi: 10.1089/chi.2013.0064

74. Lawrence SE, Puhl RM, Schwartz MB, Watson RJ, Foster GD. "The most hurtful thing I've ever experienced": a qualitative examination of the nature of experiences of weight stigma by family members. *SSM Qual Res Health.* (2022) 2:100073. doi: 10.1016/j.ssmqr.2022.100073

75. Lawrence BJ, Kerr D, Pollard CM, Theophilus M, Alexander E, Haywood D, et al. Weight bias among health care professionals: a systematic review and meta-analysis. *Obesity.* (2021) 29:1802–12. doi: 10.1002/oby.23266

76. Pearl RL, Puhl RM, Lessard LM, Himmelstein MS, Foster GD. Prevalence and correlates of weight bias internalization in weight management: a multinational study. *SSM Population Health.* (2021) 13:100755. doi: 10.1016/j.ssmph.2021.100755

77. Witcomb GL, Arcelus J, Chen J. Can cognitive dissonance methods developed in the West for combatting the 'thin ideal' help slow the rapidly increasing prevalence of eating disorders in non-Western cultures? *Shanghai Arch Psychiatry.* (2013) 25:332–40. doi: 10.3969/j.issn.1002-0829.2013.06.002

78. Thomas J, O'Hara L, Quadflieg S, Weissgerber SC. Acculturation, out-group positivity and eating disorders symptoms among Emirati women. *Eat Weight Disord Stud Anorexia Bulimia Obes.* (2017) 23:241–6. doi: 10.1007/s40519-016-0358-5

79. Mingoia J, Hutchinson AD, Wilson C, Gleaves DH. The relationship between social networking site use and the internalization of a thin ideal in females: a meta-analytic review. *Front Psychol.* (2017) 8:1351. doi: 10.3389/fpsyg.2017.01351

80. Szwimer E, Mougharbel F, Goldfield GS, Alberga AS. The association between weight-based teasing from peers and family in childhood and depressive symptoms in childhood and adulthood: a systematic review. *Curr Obes Rep.* (2020) 9:15–29. doi: 10.1007/s13679-020-00367-0

81. Emmer C, Bosnjak M, Mata J. The association between weight stigma and mental health: a meta-analysis. *Obesity Revi.* (2020) 21:e12935. doi: 10.1111/obr.12935

82. O'Hara L, Taylor J. What's wrong with the 'war on obesity?' A narrative review of the weight-centered health paradigm and development of the 3C framework to build critical competency for a paradigm shift. *SAGE Open.* (2018) 8:1–28. doi: 10.1177/2158244018772888

83. Mann T, Tomiyama AJ, Westling E, Lew A-M, Samuels B, Chatman J. Medicare's search for effective obesity treatments: diets are not the answer. *Am Psychol.* (2007) 62:220–33. doi: 10.1037/0003-066X.62.3.220

84. Azzeh M, Peachey G, Loney T. Prevalence of eating disorders and disordered eating attitudes n students in Arab countries: a scoping review. *Curr Res Nutr Food Sci.* (2022) 10:595–606. doi: 10.12944/CRNFSJ.10.2.16

85. Loth KA, MacLehose R, Bucchianeri M, Crow S, Neumark-Sztainer D. Predictors of dieting and disordered eating behaviors from adolescence to young adulthood. *J Adolescent Health.* (2014) 55:705–12. doi: 10.1016/j.jadohealth.2014.04.016

86. Sutin AR, Stephan Y, Robinson E, Daly M, Terracciano A. Body-related discrimination and dieting and substance use behaviors in adolescence. *Appetite.* (2020) 151:104689. doi: 10.1016/j.appet.2020.104689

87. Ebrahim M, Alkazemi D, Zafar TA, Kubow S. Disordered eating attitudes correlate with body dissatisfaction among Kuwaiti male college students. *J Eat Disord.* (2019) 7:37. doi: 10.1186/s40337-019-0265-z

88. Ashmore JA, Friedman KE, Reichmann SK, Musante GJ. Weight-based stigmatization, psychological distress, & binge eating behavior among obese treatment-seeking adults. *Eat Behav.* (2008) 9:203–209. doi: 10.1016/j.eatbeh.2007.09.006

89. Haines J, Neumark-Sztainer D, Eisenberg ME, Hannan PJ. Weight teasing and disordered eating behaviors in adolescents: longitudinal findings from project EAT (eating among teens). *Pediatrics.* (2006) 117:e209–15. doi: 10.1542/peds.2005-1242

90. Meadows A, Higgs S. Internalized weight stigma and the progression of food addiction over time. *Body Image.* (2020) 34:67–71. doi: 10.1016/j.bodyim.2020.05.002

91. Hunger JM, Dodd DR, Smith AR. Weight-based discrimination, interpersonal needs, and suicidal ideation. *Stigma Health.* (2020) 5:217–24. doi: 10.1037/sah0000188

92. Puhl RM, King KM. Weight discrimination and bullying. *Best Pract Res Clin Endocrinol Metab.* (2013) 27:117–27. doi: 10.1016/j.beem.2012.12.002

93. Sutin AR, Robinson E, Daly M, Terracciano A. Perceived body discrimination and intentional self-harm and suicidal behavior in adolescence. *Childhood Obesity.* (2018) 14:528–36. doi: 10.1089/chi.2018.0096

94. Falkner NH, Neumark-Sztainer D, Story M, Jeffery RW, Beuhring T, Resnick MD. Social, educational, and psychological correlates of weight status in adolescents. *Obes Res.* (2001) 9:32–42. doi: 10.1038/oby.2001.5

95. Yen YC, Huang CK, Tai CM. Psychiatric aspects of bariatric surgery. *Curr Opin Psychiatry.* (2014) 27:374–9. doi: 10.1097/YCO.0000000000000085

96. Dawes AJ, Maggard-Gibbons M, Maher AR, Booth MJ, Miake-Lye I, Beroes JM, et al. Mental health conditions among patients seeking and undergoing bariatric surgery. *JAMA.* (2016) 315:150. doi: 10.1001/jama.2015.18118

97. Castaneda D, Popov VB, Wander P, Thompson CC. Risk of suicide and self-harm is increased after bariatric surgery—a systematic review and meta-analysis. *Obes Surg.* (2019) 29:322–33. doi: 10.1007/s11695-018-3493-4

98. Müller A, Hase C, Pommnitz M, de Zwaan M. Depression and suicide after bariatric surgery. *Curr Psychiatry Rep.* (2019) 21:1–6. doi: 10.1007/s11920-019-1069-1

99. Walker L. *Qatar Doctors Raise Concerns About Weight Loss Surgeries Done Abroad.* (2014). Available online at: https://dohanews.co/2000-people-year-undergo-weight-loss-surgery/ (accessed July 24, 2014).

100. Hamad Medical Corporation. *HMC Warns Against Undergoing Bariatric Surgeries in Unreliable Medical Centers Abroad.* (2022). Available online at: https://www.hamad.qa/EN/news/2022/July/Pages/HMC-Warns-Against-Undergoing-Bariatric-Surgeries-in-Unreliable-Medical-Centers-Abroad.aspx#:$\sim$:text=He%20said%20the%20Department%20receives,1000%20bariatric%20surgeries%20every%20year (accessed July 7, 2022).

101. Callahan D. Obesity: chasing an elusive epidemic. *Hastings Center Rep.* (2013) 43:34–40. doi: 10.1002/hast.114

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