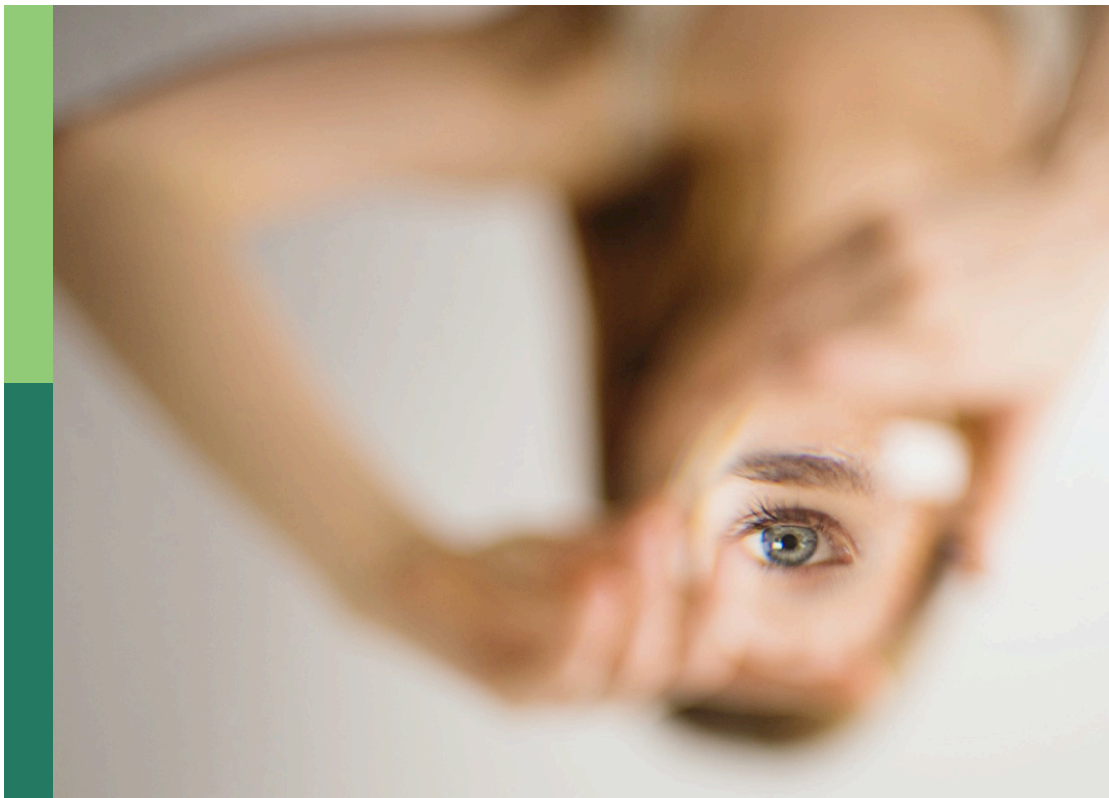
frontiers | Research Topics

Cognitive and mental health improvement under- and post-COVID-19, volume III

Edited by
Yuka Kotozaki, Gabriele Nibbio and Chong Chen

Published in
Frontiers in Psychology
Frontiers in Psychiatry



ISSN 1664-8714
ISBN 978-2-8325-6200-0
DOI 10.3389/978-2-8325-6200-0

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Cognitive and mental health improvement under- and post-COVID-19, volume III

Topic editors

Yuka Kotozaki — Iwate Medical University, Japan

Gabriele Nibbio — University of Brescia, Italy

Chong Chen — Yamaguchi University Graduate School of Medicine, Japan

Citation

Kotozaki, Y., Nibbio, G., Chen, C., eds. (2025). *Cognitive and mental health improvement under- and post-COVID-19, volume III*. Lausanne: Frontiers Media SA. doi: 10.3389/978-2-8325-6200-0

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frontiers | Frontiers in Psychology

TYPE Editorial
PUBLISHED 19 March 2025
DOI 10.3389/fpsyg.2025.1588477

OPEN ACCESS

EDITED AND REVIEWED BY
Antoine Bechara,
University of Southern California,
United States

*CORRESPONDENCE
Yuka Kotozaki
✉ kotoyuka@iwate-med.ac.jp

RECEIVED 05 March 2025
ACCEPTED 07 March 2025
PUBLISHED 19 March 2025

CITATION
Kotozaki Y, Nibbio G and Chen C (2025) Editorial: Cognitive and mental health improvement under- and post-COVID-19, volume III. *Front. Psychol.* 16:1588477. doi: 10.3389/fpsyg.2025.1588477

Editorial: Cognitive and mental health improvement under- and post-COVID-19, volume III

Yuka Kotozaki[1]*, Gabriele Nibbio[2] and Chong Chen[3]

[1]Department of Hygiene and Preventive Medicine, School of Medicine, Iwate Medical University, Morioka, Iwate, Japan, [2]Department of Clinical and Experimental Sciences, University of Brescia, Brescia, Italy, [3]Division of Neuropsychiatry, Department of Neuroscience, Yamaguchi University Graduate School of Medicine, Ube, Yamaguchi, Japan

KEYWORDS

COVID-19, pandemic, burnout, mental health, social support, urban-rural disparities, suicide rate

Editorial on the Research Topic
Cognitive and mental health improvement under- and post-COVID-19, volume III

This is a part of a collection on the Research Topic of *Cognitive and mental health improvement under- and post-COVID-19*. Please refer to the related Research Topic (Chen et al., 2025; Nibbio et al., 2025).

The COVID-19 pandemic has contributed to a global decline in mental health and cognitive function (Vindegaard and Benros, 2020; Xie et al., 2022; Hampshire et al., 2021; Chen et al., 2023; Galderisi et al., 2024), necessitating effective interventions. While factors such as regular exercise, sufficient sleep, a balanced diet, social connections, engagement with nature, and mindfulness are known to enhance cognition and mental wellbeing (Rebar and Taylor, 2015; Vancampfort and Firth, 2018; Davidson and Dahl, 2018; Chen and Nakagawa, 2019, 2020; Mizumoto et al., 2024; Nibbio et al., 2025), the optimal approaches for specific populations—both healthy and clinical—remain unclear. Further research is required to identify the most effective intervention strategies and elucidate the underlying psychological, physiological, and neurobiological mechanisms through which these interventions exert their benefits.

The aim of this Research Topic is to publish a wide range of studies that help address these unsolved issues and advance our understanding of what activities and interventions help improve cognition and promote mental health. This editorial presents a summary of the main results for the 11 manuscripts.

Zhao et al. aimed to understand job burnout among village doctors during the COVID-19 epidemic and identify influencing factors. A survey of 993 village doctors revealed a burnout incidence of 53.47%, with 54.05% experiencing mild, 33.14% moderate, and 12.81% severe burnout. Key factors associated with burnout included high work pressure, difficulty using WeChat, high practice risk, low economic and technical support, and poor emotional support. The findings highlight the need for better support and resources to alleviate job burnout among village doctors.

Xiao examined the impact of COVID-19 on urban-rural health inequality in China, focusing on the roles of socioeconomic status and social capital. Data from 1,936 participants showed that rural youth had better mental health than urban youth, especially when the pandemic was less severe. Socioeconomic status positively influenced mental

health, with a stronger effect for urban youth. Social capital also had a positive effect on mental health, but its impact was similar for both urban and rural populations. The findings highlight the complex relationship between urban-rural disparities, socioeconomic factors, and mental health during the pandemic.

Metzger et al. explored the motivations for healthcare workers and students to volunteer and examined the relationship between volunteering and burnout. Participants (eight healthcare providers, 10 graduate students, 14 undergraduate students) completed a burnout assessment and semi-structured interviews. The results showed that burnout decreased the likelihood of volunteering, but volunteering helped prevent burnout. Most participants volunteered for professional development, to make a difference, or because they felt a sense of responsibility. COVID-19 had a significant impact on both burnout and motivations. The study concluded that while volunteering can help prevent burnout, it may not benefit those already experiencing burnout. Healthcare organizations can promote volunteering by emphasizing its professional development benefits and making it more convenient for students and professionals.

He et al.'s study investigated anxiety and depression in IBD patients during the COVID-19 pandemic and analyzed contributing factors. Among 215 IBD patients, 27% reported anxiety and 34% depression. Factors positively associated with mental health issues included longer waiting times for admission, irregular oral medication, and diet changes. Conversely, timely periodic infusion of biological agents was linked to lower anxiety and depression. Changes in physical activity, sleep, COVID-19 knowledge, and self-prevention measures were not significantly correlated with mental health outcomes. The study emphasizes the importance of maintaining routine treatment and medication, as well as establishing online self-management programs for IBD patients during public health crises.

Rung et al. examined the mental health impacts of the COVID-19 pandemic on Black and White Louisiana residents, focusing on general wellbeing and identifying protective factors like social support, resilience, and social cohesion. The survey revealed that Black individuals experienced higher levels of pandemic-related stress and had lower levels of these protective factors compared to White individuals. However, both groups benefited from social support, resilience, and social cohesion, though these protective effects weakened as pandemic impacts increased. Racial disparities were observed in how these protective factors deteriorated over time. The study highlights the need for targeted interventions to support vulnerable communities, especially minority groups, by enhancing psychosocial resources to mitigate the mental health effects of future crises.

Claessens et al. investigated cognitive and psychological outcomes in non-hospitalized post-COVID-19 patients with persistent symptoms, more than 3 months after infection. A total of 265 patients (61% female, average age 51.7 years) were assessed for anxiety, depression, PTSD, and cognitive symptoms. Results showed that 40% had high anxiety, 43% had depression, 31% had PTSD, and 79% reported cognitive symptoms. Bivariate analysis indicated that a history of psychiatric conditions and physical symptoms were linked to higher psychological and cognitive symptoms. Multivariate analysis found that catastrophizing thoughts were associated with higher anxiety, while positive refocusing was linked to lower anxiety, depression, PTSD, and cognitive symptoms. These findings highlight the role of physical symptoms, psychiatric history, and coping strategies in post-COVID outcomes, underscoring the need for biopsychosocial treatment approaches.

Chen et al. assessed risk and protective factors for sufficient sleep among adolescents during the COVID-19 pandemic using data from the 2021 Adolescent Behaviors and Experiences Survey (n = 7,705). Only 23.5% of U.S. high school students reported getting sufficient sleep. Factors as sociated with sufficient sleep included younger age, heterosexual identity, absence of poor mental health, no feelings of sadness or hopelessness, no food insecurity, no emotional abuse, and no schoolwork difficulty. The findings suggest that addressing these factors can help improve sleep duration in adolescents, especially during future pandemics.

Li et al.'s study examined the prevalence and correlates of mental health disorders among Chinese primary healthcare (PHC) physicians and nurses in 2022, post-pandemic. A national sample of 4,246 respondents was surveyed using various mental health assessment tools. Results indicated a decrease in most mental health disorders compared to the early pandemic, except for somatization, phobic anxiety, and obsessive-compulsive disorder. Significant risk factors for mental health issues included female gender, multimorbidity, psychiatric history, quarantine experience, lack of social support, and overtime work. The study highlights the need for regular assessments and psychological support for PHC professionals to address work-related stress and preexisting health conditions.

Wang et al. adapted the Tendency to Stigmatize Epidemic Diseases Scale (TSEDS) into Chinese using the Brislin translation model. They conducted a survey with 434 adults and evaluated various aspects like reliability and validity. The Chinese version of TSEDS consists of 27 items across five dimensions: structural stigma, perceived stigma, organizational stigma, internalized stigma, and social stigma. The scale showed high content validity (0.975), good model fit indices, and strong reliability (Cronbach's alpha = 0.962). Test-retest reliability was 0.912, confirming the scale's consistency and validity.

Nouhi Siahroudi et al. conducted a study to assess the impact of COVID-19 on suicide rates in Iran using an interrupted time series analysis. They analyzed 63,514 suicide cases from April 2009 to March 2023. Results showed a significant increase in the suicide rate during the pandemic, with a 1.003 times increase per month and a 1.1 times rise after accounting for the pandemic. However, no significant interaction between time and COVID-19 was found. While the suicide rate was already rising before the pandemic, a notable increase in suicide deaths occurred 3 months after the pandemic began, suggesting COVID-19 may have influenced suicide rates.

Huang et al.'s study investigated factors affecting the sleep quality of frontline medical personnel during the peak of the COVID-19 pandemic in Shanghai. A cross-sectional survey (June 25–July 14, 2022) analyzed weight change, job title, and tea consumption using PSQI scores. Data from 1,326 participants were split into training (80%) and validation (20%) sets. Six predictive models were tested, with the deep learning (DL) model

showing the best predictive performance (AUC = 0.656, specificity = 86.1%, sensitivity = 45.5%). Sleep quality was influenced by multiple factors, with DL emerging as the most effective predictive tool.

In conclusion, the editors wish to thank all the authors, the reviewers, and the editorial board members for contributing to this Research Topic. As was the case during the COVID-19 pandemic, emerging infectious diseases pose a serious threat to public health worldwide and their impact is not only on physical health but also on mental health. We hope that this Research Topic will inspire future novel research approaches in the field of mental health.

Author contributions

YK: Writing – original draft, Writing – review & editing. GN: Writing – review & editing. CC: Writing – review & editing.

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.

The author(s) declared that they were an editorial board member of Frontiers, at the time of submission. This had no impact on the peer review process and the final decision.

Publisher's note

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frontiers | Frontiers in Public Health

TYPE Original Research
PUBLISHED 18 April 2024
DOI 10.3389/fpubh.2024.1388831

OPEN ACCESS

EDITED BY
Chong Chen,
Yamaguchi University Graduate School of Medicine, Japan

REVIEWED BY
Massimo Tusconi,
University of Cagliari, Italy
Isa Multazam Noor,
Yarsi University, Indonesia

*CORRESPONDENCE
Zhongming Chen
✉ czm3306196@163.com
Wenqiang Yin
✉ yinwq1969@126.com

†These authors have contributed equally to this work and share first authorship

RECEIVED 20 February 2024
ACCEPTED 01 April 2024
PUBLISHED 18 April 2024

CITATION
Zhao Z, Li Q, Yang C, Zhang Z, Chen Z and Yin W (2024) Job burnout and its influencing factors among village doctors during the COVID-19 pandemic: a cross-sectional study. *Front. Public Health* 12:1388831. doi: 10.3389/fpubh.2024.1388831

Job burnout and its influencing factors among village doctors during the COVID-19 pandemic: a cross-sectional study

Zixuan Zhao[1†], Qiusha Li[1†], Chunxiao Yang[1], Zhongzheng Zhang[2], Zhongming Chen[3*] and Wenqiang Yin[3*]

[1]School of Public Health, Shandong Second Medical University, Weifang, Shandong, China, [2]Hepatic Biliary Pancreatic Surgery, Yidu Central Hospital of Weifang, Shandong, China, [3]School of Management, Shandong Second Medical University, Weifang, Shandong, China

Objective: The aim of this study is to understand the job burnout of village doctors during the COVID-19 epidemic and its influencing factors, and to provide a reference for effectively alleviating the job burnout of village doctors.

Methods: A cross-sectional survey was conducted among village doctors in S province in December 2021. The survey included a general information questionnaire and the CMBI Burnout Scale. Epidata was used for dual input, and descriptive analysis, *t*-test, chi-square test, and binary Logistic regression for statistical analysis were used.

Results: A total of 993 village doctors participated in the survey. Most of them were male village doctors (62.84%), with an average age of 46.57 (SD = 7.50). Village doctors believed that the impact of the epidemic on work was serious, with a score of 3.87 ± 0.91. The economic support was small, with a score of 2.31 ± 0.99. The development space was low, with a score of 2.62 ± 0.98. The overall incidence of burnout was 53.47%. In the burnout group, 54.05% were mild, 33.14% were moderate, and 12.81% were severe. The high degree of difficulty in using WeChat (*OR* = 1.436, 95%*CI*: 1.229–1.679), high work pressure (*OR* = 1.857, 95%*CI*: 1.409–2.449), high risk of practice (*OR* = 1.138, 95%*CI*: 1.004–1.289), less economic support (*OR* = 0.825, 95%*CI*: 0.684–0.995), less technical support (*OR* = 0.696, 95%*CI*: 0.565–0.858), and poor emotional support (*OR* = 0.632, 95%*CI*: 0.513–0.780) were more likely to have job burnout.

Conclusion: Burnout is a common phenomenon among village doctors during the COVID-19 pandemic, which needs to be prevented and alleviated by various measures.

KEYWORDS

COVID-19 pandemic, village doctors, job burnout, influencing factors, rural health

1 Introduction

Attaching importance to the development of grass-roots health services is the goal of China's medical and health system reform (1). Village doctors in China are responsible for most of the medical care and public health services in rural areas, and are an important part of the medical and health team. Medical care responsibility refers to the basic treatment of

common diseases, frequently occurring diseases and chronic diseases, and guides patients to see a doctor in time. Public health service responsibility refers to the establishment of unified and standardized health records for residents in the jurisdiction, regular health knowledge lectures and other 14 national basic public health service projects. Village doctors, as the health "guardians" closest to hundreds of millions of rural residents, have made great contributions to the prevention and treatment of acute and chronic diseases of rural people for many years (2). As a major public health emergency, the epidemic of novel coronavirus pneumonia (Coronavirus disease 2019, COVID-19) has affected a wide range of areas. In addition, sociocultural changes and economic difficulties caused by the prolongation of the epidemic have led to a variety of psychological problems, such as anxiety, depression, panic, burnout, etc. (3–5). Village doctors, as front-line participants in epidemic prevention and control in rural areas, actively fulfilled their duties of screening people from outside and returning home and screening patients with fever. This has played an important role in effectively preventing the spread of the epidemic to rural areas and protecting the health of residents in rural areas (6).

The theory of effort-and-reward imbalance states that the efforts made by individuals at work need to be rewarded in terms of salary, respect, and career development. If there is an imbalance between effort and reward, it will have a negative impact on employee behavior and health, and the long-term imbalance will also lead to negative feelings and tension among staff, leading to job burnout (7). In this epidemic prevention and control, village doctors have done a lot of work, resulting in a sharp increase in their workload, work pressure and practice risks. However, they have not been rewarded in a way that matches their efforts. This may lead to job burnout among village doctors.

Job burnout, also known as burnout or occupational exhaustion, is a psychological syndrome. Job burnout refers to the individual's long-term stress at work, which leads to physical and mental exhaustion of attitude, emotion, and behavior, resulting in indifference or boredom to work (8, 9). Maslach argues that job burnout is not caused by unilateral causes, either professional or personal, but depends on the balance between personal expectations and professional requirements (10). Job burnout includes three dimensions: emotional exhaustion, depersonalization, and reduced personal accomplishment. The exploration of burnout has deepened in the past few decades. Relevant studies have shown that job burnout exists in various industries (11–13). Among them, the phenomenon of burnout in the medical field is serious, especially in the medical and nursing groups during the COVID-19 epidemic. Scholars such as Chen (14), Vranas (15), Magalh Magalhães (16), and Szczerbińska (17) respectively studied the burnout status and influencing factors of doctors and nurses in large general hospitals during the COVID-19 epidemic. Peng (18), Chen (19), and other scholars studied the current situation and influencing factors of job burnout of medical staff in primary medical institutions during the COVID-19 epidemic. Job burnout of medical staff during the pandemic has become a hot research topic at home and abroad, and it is found that most of the studies are concentrated in tertiary hospitals. In previous studies, there were few investigations on the current situation of job burnout of village doctors since the outbreak of COVID-19. Especially in the regular prevention and control of the COVID-19 epidemic, village doctors are on the front line of managing and maintaining medical services in rural areas. Village doctors are not only facing a higher risk of infection than the general public, but also facing heavy tasks and prominent contradictions between doctors and patients. At the same time, they do not receive the social status, welfare and treatment commensurate with the status of doctors, and more prone to mental health problems. Therefore, it is particularly important to understand the current situation of job burnout of village doctors.

Based on the above background, this study aims to use cross-sectional survey data to analyze the prevalence of job burnout among village doctors in China in the context of COVID-19. And further explore the demographic characteristics, occupational stress, career development support, and other factors on burnout, which is particularly important to effectively alleviate job burnout psychology, so that village doctors maintain a higher combat effectiveness, cohesion and enthusiasm for work.

2 Methods

2.1 Study design and sampling

S Province is a province in eastern China. By the end of 2021, there are 16 prefecture-level cities (below the provincial level and above the county level) in S province, with a population of 101.527 million, of which 37.513 million are rural residents. The *per capita* disposable income of residents in the province is 35,705 yuan. There are 52,940 village clinics and 97,782 village doctors in S province, with an average of 1.85 village doctors per village clinic (20).

The survey was conducted in December 2021, and the respondents were village doctors. A stratified random sampling method was used to select three cities in S province according to their good, medium, and poor economic levels. In the same way, three counties were randomly selected from each prefecture-level city, three townships were selected from each county, and one village doctor was randomly selected from each village clinic in three townships. The selected personnel went to the township health centers to fill in the questionnaire. Before the investigation, all investigators should receive standardized training. In the survey, a special person is responsible for the quality review of the questionnaire. If problems are found, the respondents will be invited to supplement and improve the questionnaire in time. The questionnaires were reviewed again after the survey, and the unqualified questionnaires were excluded from the follow-up analysis. A total of 1,093 questionnaires were distributed in this research, 100 invalid questionnaires containing missing values were removed using the deletion method and 993 valid questionnaires were recovered, with an effective recovery rate of 90.85% (Effective recovery rate of questionnaires = recovered valid questionnaires/issued questionnaires × 100%). In addition, the survey was conducted anonymously, all participants gave informed consent, and the study protocol was approved by the Ethics Committee of Weifang Medical University (ID: 2021YX-066).

2.2 Measurement

2.2.1 General survey

Socio-demographic variables of village doctors, gender (1 = male, 2 = female), age (1 = Under 40, 2 = 40–49 years old, 3 = At least 50 years old), working years (1 = Less than 10 years, 2 = 10–19 years,

3 = 20–29 years, 4 = At least 30 years), educational background (1 = junior middle school or below, 2 = technical secondary school, 3 = junior college or above). Qualification (1 = village doctor license, 2 = licensed assistant doctor, 3 = licensed doctor), difficulty in using WeChat (1 = very small to 5 = very large), annual household income (1 = Less than 30,000 yuan, 2 = 30,000–59,999 yuan, 3 = 60,000–99,999 yuan, 4 = Greater than or equal to 100,000 yuan).

In terms of occupational stress, workload, work pressure, and practice risk are all on the scale of 1–5, 1 = very small, 5 = very large. In the aspect of career development support, economic support, technical support, institutional support, development space, resource support, and emotional support are all on the scale of 1–5, 1 = very unsupportive, 5 = very supportive.

2.2.2 Job burnout

In this study, the CMBI burnout scale revised by Li and Li (21) was used. The scale consists of three dimensions: emotional exhaustion, depersonalization, and reduced personal accomplishment, with a total of 15 items. This scale was developed on the basis of relevant studies at home and abroad, and has been well validated in subsequent large-scale studies (22). At present, the scale is used in China Journal Full-text Database (CJFD). This study changed the seven-point scale to a five-point scale (1 never, 2 rarely, 3 sometimes, 4 often, and 5 always). Because in the pre-survey process, it was found that a large number of respondents said it was difficult to distinguish the answers of the seven-point scale, and the five-point scale was more suitable for Chinese cultural background. Moreover, the five-point classification has been adopted by many scholars (23, 24). In this study, the Cronbach's alpha coefficients of CMBI and its three dimensions of emotional exhaustion, depersonalization, and reduced sense of achievement were 0.82, 0.93, 0.88, and 0.87, respectively, indicating that the questionnaire had good reliability.

The latest MBI manual (fourth edition) suggests that the scores of the three dimensions should not be accumulated to form a single burnout score (25). Li Yongxin's criteria (21) were used in this study. In SPSS statistical analysis software, the scores of emotional exhaustion, depersonalization, and reduced sense of achievement were sorted, and the value of 1/3 of each dimension was calculated as the critical value. Among them, emotional exhaustion and depersonalization take the upper tertile, the sense of achievement takes the lower tertile, and burnout occurs when it reaches the standard. Specific critical values are shown in Table 1. We defined zero burnout as the score of the three dimensions did not exceed the critical value. One of the dimensions exceeding the critical value was mild burnout. Two dimensions exceeding the critical value were considered as moderate burnout. Three dimensions exceeding the critical value were severe burnout. The most prominent advantage of this evaluation criterion is that it considers the comprehensive effect of the three factors of job burnout, and the investigation is more comprehensive. In addition, grading the level of burnout will also help to take more targeted prevention and intervention measures.

TABLE 1 Critical value of each dimension of job burnout.

Dimension	Critical value
Emotional exhaustion	>17
Depersonalize	>10
The sense of accomplishment is reduced	<23

Li Yongxin's criteria were used in this study. The scores of emotional exhaustion, depersonalization, and reduced sense of achievement were sorted, and the value of 1/3 of each dimension was calculated as the critical value. Emotional exhaustion and depersonalization take the upper tertile, the sense of achievement takes the lower tertile, and burnout occurs when it reaches the standard.

2.3 Statistical analysis

SPSS 21.0 software was used for statistical analysis. Enumeration data were expressed as frequency and percentage, and measurement data were expressed as $\bar{x} \pm S$. The *t*-test and Chi-square test were used to compare the job burnout of different demographic characteristics. Binary Logistic regression analysis was used to identify the influencing factors of job burnout of village doctors. The dependent variable job burnout was treated as a dichotomous variable (zero burnout defined as no burnout occurring, assigned a value of 0, and mild, moderate, and severe burnout defined as burnout occurring, assigned a value of 1). Statistically significant variables in the univariate analysis were included in the regression model as independent variables.

3 Results

3.1 Socio-demographic characteristics of village doctors

Most of the respondents were male (62.84%), with an average age of 46.57 years (SD = 7.50), and 52.87% were 40–49 years old. 52.87% of village doctors have worked for 20–29 years, and only 2.11% of them have worked for less than 10 years. Among the respondents, 54.38% had secondary school education, 60.32% had village doctor's license, and 12.19% had licensed doctor's license. 47.94% of village doctors think that there are some difficulties in using WeChat. The survey found that the annual household income of village doctors was concentrated in 30,000–59,999 yuan (51.06%), and 9.37% of village doctors had an annual household income of more than 100,000 yuan (Table 2).

3.2 Occupational stress and support for career development of village doctors

In terms of occupational stress, the scores of workload, work stress and practice risk were 3.51 ± 0.61, 3.58 ± 0.72, and 3.18 ± 1.31, respectively. In the aspect of career development support, the scores of economic support, technical support, institutional support, development space, resource support, and emotional support were 2.31 ± 0.99, 3.66 ± 0.93, 3.31 ± 0.89, 2.62 ± 0.98, 3.06 ± 1.07, and 4.00 ± 0.85, respectively (Table 2).

3.3 Job burnout status of village doctors

Of the 993 village doctors interviewed, 46.53% had zero burnout and 53.47% had burnout. In the burnout group, 54.05% were mild, 33.14% were moderate, and 12.81% were severe (Table 3).

10.3389/fpubh.2024.1388831

TABLE 2 Single factor analysis of job burnout of village doctors.

Variables	Total N (%)/$\bar{x} \pm SD$	Burnout N (%)/$\bar{x} \pm SD$	χ^2/t	*p* value
Gender				
Male	624 (62.84)	354 (56.73)	7.157	0.007
Female	369 (37.16)	177 (47.97)		
Age				
<40	151 (15.21)	80 (52.98)	0.083	0.959
40–49	525 (52.87)	283 (53.90)		
≥50	317 (31.92)	168 (53.00)		
Years of service				
<10	21 (2.11)	6 (28.57)	6.043	0.110
10–19	168 (16.92)	95 (56.55)		
20–29	525 (52.87)	278 (52.95)		
≥30	279 (28.10)	152 (54.48)		
Academic qualifications				
Junior high school and below	9 (0.91)	6 (66.67)	1.208	0.547
Technical secondary school	540 (54.38)	294 (54.44)		
College degree or above	444 (44.71)	231 (52.03)		
Practicing qualification				
Village doctor's license	599 (60.32)	322 (53.76)	1.337	0.512
Assistant practicing physician	273 (27.49)	150 (54.95)		
Medical practitioner	121 (12.19)	59 (48.76)		
Difficulty in using WeChat				
Rarely	107 (10.78)	38 (35.51)	48.510	<0.001
Occasionally	143 (14.40)	60 (41.96)		
Sometimes	476 (47.94)	249 (52.31)		
Often	239 (24.07)	162 (67.78)		
Always	28 (2.82)	22 (78.57)		
Annual household income				
<30,000	203 (20.44)	117 (57.63)	1.924	0.588
30,000–59,999	507 (51.06)	267 (52.66)		
60,000–99,999	190 (19.13)	100 (52.63)		
≥100,000	93 (9.37)	47 (50.54)		
Workload	3.51 ± 0.61	3.58 ± 0.64	−3.779	<0.001
Work pressure	3.58 ± 0.72	3.78 ± 0.69	−10.031	<0.001
Practice risk	3.18 ± 1.31	3.49 ± 1.26	−8.502	<0.001
Economic support	2.31 ± 0.99	2.04 ± 0.87	9.79	<0.001
Technical support	3.66 ± 0.93	3.40 ± 0.93	10.132	<0.001
Institutional support	3.31 ± 0.89	3.03 ± 0.85	11.450	<0.001
Space for development	2.62 ± 0.98	2.40 ± 0.96	7.857	<0.001
Resource support	3.06 ± 1.07	2.83 ± 1.04	7.262	<0.001
Emotional support	4.00 ± 0.85	3.75 ± 0.87	10.685	<0.001

3.4 Single factor analysis of job burnout of village doctors

The results showed that gender, difficulty in using WeChat, workload, work pressure, practice risk, economic support, technical support, institutional support, development space, resource support, and emotional support had an impact on job burnout of village doctors ($p < 0.05$) (Table 2).

3.5 Binary logistic regression analysis on influencing factors of job burnout of village doctors

Burnout was used as the dependent variable (0 = zero burnout, 1 = burnout). Binary Logistic regression analysis was conducted with gender, difficulty in using WeChat, workload, work pressure, practice risk, economic support, technical support, institutional support, development space, resource support, and emotional support as independent variables.

Village doctors with high difficulty in using WeChat are more likely to have job burnout ($p < 0.001$, $OR = 1.436$, 95% *CI*: 1.229–1.679). Job burnout was more likely to occur in respondents with higher work stress ($p < 0.001$, $OR = 1.857$, 95% *CI*: 1.409–2.449). Village doctors with higher practice risk were more likely to have job burnout ($p < 0.05$, $OR = 1.138$, 95% *CI*: 1.004–1.289). The less economic support, the more job burnout of village doctors ($p < 0.05$, $OR = 0.825$, 95% *CI*: 0.684–0.995). Those with less technical support were more likely to have job burnout ($p < 0.01$, $OR = 0.696$, 95% *CI*: 0.565–0.858). The worse the emotional support, the easier the job burnout ($p < 0.001$, $OR = 0.632$, 95% *CI*: 0.513–0.780). Gender, workload, institutional support, development space, and resource support have no effect on job burnout of village doctors ($p > 0.05$) (Table 4).

4 Discussion

In this study, 993 village doctors in S Province were surveyed and interviewed to explore the current situation and influencing factors of job burnout of village doctors in China during the COVID-19 epidemic. The results showed that the job burnout rate of village doctors was 53.47%. The degree of difficulty in using WeChat, work pressure, practice risk, economic support, technical support, and emotional support all have an impact on the job burnout of village doctors during the epidemic.

The study found that the burnout rate of village doctors in China during the COVID-19 pandemic was 53.47%. Chinese scholar Zhao et al. (26) investigated the burnout of village doctors during the epidemic prevention and control period, and the detection rate of burnout was 56.3%. Chen Yunfeng (19), Chen Dongran (27), and other scholars surveyed grass-roots medical staff in Shanghai and Xinjiang during the COVID-19 epidemic, and found that the burnout rates were 63.6 and 48.5%, respectively. The results of the above studies are similar to those of this study. According to the research of Hain et al. (28), a South African scholar at the same time, 68.5% of village doctors suffered from burnout during the COVID-19 epidemic. Austrian scholar Kurzthaler et al. (29) and Australian scholar Hoffman

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TABLE 3 Mild, moderate, and severe job burnout of village doctors.

Degree of burnout	Number of people	Proportion (%)
Mild burnout	287	54.05
Moderate burnout	176	33.14
Severe burnout	68	12.81

Li Yongxin's criteria were used in this study. One of the dimensions exceeding the critical value was mild burnout. Two dimensions exceeding the critical value were considered as moderate burnout. Three dimensions exceeding the critical value were severe burnout.

et al. (30) assessed the prevalence of burnout among general practitioners during the COVID-19 pandemic, which was 70.0 and 75.0%, respectively. These studies were higher than the detection rate of job burnout of village doctors in this study.

Village doctors who have difficulty in using WeChat have a higher rate of job burnout, which is consistent with the research of Li Xungui and Parkinson (31, 32). The reason may be that the unbalanced age structure of village doctors was found during the survey, with a relatively high proportion of doctors aged over 50. The older people are, the less able they are to accept new knowledge and technology, which leads to the difficulty of using network tools for village doctors. However, during the COVID-19 pandemic, the work of village doctors is highly dependent on communication tools, which is a burden for village doctors with heavy tasks and older age. Job burnout can easily result from job demands that exceed one's ability (28).

Village doctors with greater work pressure are more likely to suffer from job burnout, which is consistent with the research results of scholars such as La and Yuan Beibei (33, 34). The reason may be that village doctors, as grass-roots front-line personnel in the fight against the epidemic, not only need to provide basic medical and public health services, but also need to undertake temperature monitoring, nucleic acid collection, health education and other work. Epidemic prevention and control work not only increased the working hours of village doctors, but also increased the intensity of work. Studies have shown that in the state of overload, doctors not only cannot provide more effective services for patients, but also are harmful to physical and mental health, and are prone to job burnout (35).

Village doctors with higher practice risk have a higher level of job burnout, which is consistent with the research of scholars such as Jia Haiyi and Izhar (36, 37). Analysis of the possible reasons, first, the novel coronavirus pneumonia has the characteristics of strong infectivity and fast transmission. Village doctors, as front-line anti-epidemic personnel, are facing a greater risk of infection, and it is very easy to have burnout in their work if their own safety is not guaranteed. Second, the closure of the epidemic has brought tremendous psychological pressure to the public, and problems such as anxiety and depression occur frequently. This also invisibly increases the difficulty and risk of the work of village doctors. At present, the risk-sharing mechanism of village doctors is not sound, and village doctors in most areas need to take full responsibility in the face of medical risks. The current situation of "high risk, low security" makes village doctors avoid their work, affects their work enthusiasm, and then produces burnout psychology.

TABLE 4 Binary logistic regression analysis on influencing factors of job burnout of village doctors.

Variables	β	SE	*p* value	OR	95% CI
Gender	−0.198	0.150	0.187	0.820	0.611,1.101
WeChat is difficult to use	0.362	0.080	<0.001	1.436	1.229,1.679
Workload	−0.172	0.150	0.249	0.842	0.628,1.128
Work pressure	0.619	0.141	<0.001	1.857	1.409,2.449
Practice risk	0.129	0.064	0.043	1.138	1.004,1.289
Economic support	−0.192	0.095	0.044	0.825	0.684,0.995
Technical support	−0.362	0.107	0.001	0.696	0.565,0.858
Institutional support	−0.149	0.125	0.233	0.861	0.674,1.101
Development space	−0.082	0.087	0.343	0.921	0.777,1.092
Resource support	0.030	0.086	0.730	1.030	0.871,1.219
Emotional support	−0.458	0.107	<0.001	0.632	0.513,0.780

Village doctors with less economic support are more likely to suffer from job burnout. Analysis of the reasons may be, first, village doctors affected by the epidemic, increased workload, extended working hours, but the source of income is still composed of general medical fees, public health subsidies, and basic drug subsidies. The workload of the epidemic surge has not been matched by the income, and the imbalance between pay and return can easily lead to burnout. Second, at present, village doctors cannot enjoy the pension insurance benefits of enterprise employees, but can only participate in the medical insurance of urban and rural residents as residents, and the level of pension security is poor. However, ERG theory mentions that old-age security is a basic survival need, and unmet survival needs are important factors affecting job satisfaction, career choice, turnover intention, and job burnout (38–40).

Village doctors with less technical support have a higher rate of job burnout, which is consistent with the findings of Cohen et al. (41). First, on-the-job training is the main way for village doctors to receive external technical support, but the task of village doctors is arduous. After the village doctors participated in the training, no one took over the work, resulting in insufficient training time. Village doctors have no time to learn and make progress, and their development space is limited, which aggravates their burnout. Second, during the epidemic period, due to the impact of control, village doctors participated in training mostly in township hospitals, and the training platform limited the opportunities for village doctors to contact higher-level doctors. This situation is not conducive to the sustainable development of village doctors themselves, nor to their future career planning, which leads to burnout. Thirdly, the participation of village doctors in training is mainly based on distance/video teaching, which is out of touch with

practice. This training mode is not conducive to the improvement of their own technical level, and the career development needs of village doctors cannot be met. In addition, the training content is mostly focused on epidemic prevention and control, and there is a phenomenon of inadequate training. This makes it more difficult for village doctors to participate in epidemic prevention and control work, and they are prone to make mistakes, which aggravates burnout (42).

The worse the emotional support, the higher the level of job burnout of village doctors. First, the support of superior leaders can stimulate the work motivation of village doctors and fully tap their work potential. On the contrary, the weakening of leadership emotional support will reduce the enthusiasm of village doctors, and then lead to burnout. Second, village doctors can devote themselves more wholeheartedly to their work with the support of their families. During the epidemic, village doctors faced a greater risk of infection, isolation, lack of family and friends, and the weakening of emotional support exacerbated the emotional exhaustion of village doctors (43).

The advantage of this study is that there have been few reports on the job burnout of village doctors since the outbreak of COVID-19. This study explored the current situation of job burnout among village doctors under the specific situation of the novel coronavirus epidemic, and further identified its influencing factors. On the one hand, it enriches the relevant data on job burnout at the grassroots level and provides new evidence and perspective for the study of job burnout. On the other hand, more targeted suggestions can be made to improve the phenomenon of job burnout, which will help the stability and development of the village doctor workforce and is important for the promotion of primary health care. However, the following limitations of this study have to be recognized. First of all, the questionnaire data in this study were obtained through the respondents' self-filling, and there would inevitably be recall bias, which would have a certain impact on the results. Second, in cross-sectional study design, causality is difficult to determine, the future needs to conduct longitudinal research. Finally, although this study has explored a series of influences on job burnout, it has yet to evaluate the protective factors of job burnout such as psychotherapy, counseling interventions, etc. These limitations should be considered and further improved in the follow-up study.

5 Conclusion

Since the new medical reform, the government has issued a series of policies to promote the development of village doctors, but village doctors are still a weak link in the medical and health system. This study investigates the current situation and influencing factors of job burnout of village doctors in China under the background of COVID-19, which provides a reference for more targeted elimination of burnout psychology of village doctors. The results show that the burnout rate of village doctors is generally high. Job burnout is related to factors such as difficulty in using WeChat, high work pressure, high practice risk, less economic support, less technical support, and poor emotional support. In order to effectively alleviate the job burnout of village doctors, it is necessary to ensure that government subsidies are in place in full and on time, especially to ensure that the income of village doctors is commensurate with their efforts during the epidemic. In addition, we should design and improve the old-age security mechanism of village doctors, improve the old-age security treatment, and effectively alleviate the job burnout of village doctors.

Data availability statement

The original contributions presented in the study are included in the article, further inquiries can be directed to the corresponding authors.

Ethics statement

This study was approved by the Ethics Committee of Weifang Medical University. Participants provided consent to participate in the study.

Author contributions

ZiZ: Data curation, Methodology, Writing – original draft, Writing – review & editing. QL: Methodology, Supervision, Writing – original draft, Writing – review & editing. CY: Data curation, Supervision, Writing – original draft, Writing – review & editing. ZhZ: Data curation, Supervision, Writing – original draft, Writing – review & editing. ZC: Funding acquisition, Supervision, Writing – original draft, Writing – review & editing. WY Funding acquisition, Supervision, Writing – original draft, Writing – review & editing.

Funding

The author(s) declare financial support was received for the research, authorship, and/or publication of this article. This study was supported by the National Natural Science Foundation of China (72274140), the Humanities and Social Science Fund Ministry of Education of China (22YJAZH137), and the Taishan Scholar Project of Shandong Province (tsqn202312250).

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

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frontiers | Frontiers in Public Health

TYPE Original Research
PUBLISHED 17 May 2024
DOI 10.3389/fpubh.2024.1389765

OPEN ACCESS

EDITED BY
Yuka Kotozaki,
Iwate Medical University, Japan

REVIEWED BY
Semra Bulbuloglu,
Istanbul Aydın University, Türkiye
Keisuke Kokubun,
Kyoto University, Japan

*CORRESPONDENCE
Yang Xiao
✉ xiaoyang2017@snnu.edu.cn

RECEIVED 22 February 2024
ACCEPTED 06 May 2024
PUBLISHED 17 May 2024

CITATION
Xiao Y (2024) Mental health inequality between urban and rural youth under COVID-19 from survey data from China. *Front. Public Health* 12:1389765. doi: 10.3389/fpubh.2024.1389765

Mental health inequality between urban and rural youth under COVID-19 from survey data from China

Yang Xiao*

School of Philosophy, Shaanxi Normal University, Xi'an, China

Background: While health inequality has been the focus of past scholarly discussions, COVID-19's outbreak and spread have provided a new arena for discussing health inequality, particularly in the context of urban–rural disparities in China. This paper explores the impact of COVID-19 on urban–rural health inequality, and the roles played by socioeconomic status and social capital.

Methods: A cross-sectional observational collected data on demographics, mental health, socioeconomic status, and social capital. An online survey was administered from August 27 to August 30, 2020, and, 1936 valid samples were received. Mental health was measured using the Brief Symptom Inventory (BSI-18). This study applied the ordinary least squares regression (OLS) model, and data analysis was performed using STATA.

Results: There were 1936 participants, with an equal distribution of genders. Multiple regression analysis showed that the mental health levels of rural youth were superior to those of urban youth ($p = 0.049$), especially when the epidemic was not severe ($p = 0.013$). Socioeconomic status had a significant positive promotion effect on mental health ($p = 0.008$), but the interaction effect between socioeconomic status and the urban–rural divide indicated that the promotion effect of socioeconomic status on the mental health of urban youth was greater than that of rural youth ($p = 0.04$). Social capital had a significant positive promotion effect on mental health ($p = 0.000$), and the interaction effect indicated that this promoting effect did not differ between urban and rural areas ($p > 0.05$).

KEYWORDS

mental health, socioeconomic status, social capital, urban–rural differences, COVID-19

1 Introduction

Studies on disasters have shown that besides harming to people's lives and property, disasters can have long-term effects on people's mental health. However, these effects are not uniform or randomly distributed (1, 2). Large-scale socio-epidemiological investigations have also revealed a highly stable inverse relationship between socioeconomic status and mental disorders (3–5). Scholars refer to this phenomenon as health inequality (6–10). As a global public health emergency, the outbreak and spread of COVID-19 have provided a new arena for discussing health inequalities.

China's unique urban–rural dual system has led to a large gap between rural and urban areas in levels of economic development, medical resources, and social security (11, 12). Residents' health shows a high degree of urban–rural inequality (13). COVID-19, a highly contagious disease, is spread through person-to-person contact and asymptomatic transmission. Did the outbreak and spread of COVID-19 widen or narrow the health inequalities between urban and rural areas?'.

The relationship between socioeconomic status and mental health is considered another form of health inequality (14). Research has indicated differences in the health effects of socioeconomic status between urban and rural areas (15, 16). What impact did the outbreak and spread of COVID-19 have on the differential effects of socioeconomic status on the mental health of urban and rural residents?

Social capital, as a key factor influencing health inequality, has become a focal point for scholars (17, 18). However, epidemic prevention measures such as home quarantine and maintaining social distance have confined individuals to isolated spaces, disrupting interpersonal connections. Communication has been limited to online interactions, strengthening family-centered traditional social relationships and forming new forms of epidemic social capital (19). How will this new form of epidemic social capital affect health inequality among urban and rural youth?

This paper analyzes the above three questions using online survey data.

2 Literature review and hypotheses

2.1 Mental health disparities between urban and rural youth

The classic stress exposure mechanism posits that there are structural differences in the extent of exposure to stressors, with lower socioeconomic status groups subjected to more stress due to harsh living and working environments (20, 21). It is this structural difference that leads to health inequality. The direction of the stress exposure mechanism needs to be reconsidered when applying a unique stressor like the COVID-19 pandemic, because the large-scale population concentration and high mobility in urban areas exacerbate virus transmission, whereas rural areas have lower population density and more dispersed living conditions that, are less conducive to virus spread. Therefore, compared to rural youth, urban youth are more exposed to stressors from the COVID-19 pandemic, potentially resulting in lower levels of psychological well-being. Hence, the following research hypothesis is proposed:

> *Hypothesis 1*: urban youth's mental health is lower than rural youth.

2.2 The urban–rural difference in the effect of socioeconomic status

The urban–rural difference in the effect of socioeconomic status on health inequality has received extensive support in domestic and international research. Further studies indicate that the effect of socioeconomic status on health can be influenced by the level of national or regional development (13). The effect of socioeconomic status on health is smaller in regions with higher economic income levels, while the effect is greater in regions with lower income levels (15, 16). This is a manifestation of the theory of resource substitution, where the absence of one resource makes another resource more valuable (14, 22). Since China's unique urban–rural system results in significant disparities between urban and rural areas in terms of medical health security and accessibility to medical services (11, 12), the lack of public resources for rural youth during the pandemic made them more reliant on the socioeconomic status resources they possess. Hence, the following research hypothesis is proposed:

> *Hypothesis 2*: the effect of socioeconomic status on the mental health of rural youth is greater than that of urban youth.

2.3 The urban–rural difference in the effect of social capital

Bian and his colleagues conducted a specific study on the relationship between social capital and mental health during the COVID-19 pandemic, pointing out that both bonding social capital and bridging social capital can enhance people's ability to resist risks, thereby improving their health (19, 23, 24). Compared to urban areas, the urban–rural dual structure results in poorer institutional development for health protection in rural areas (such as medical and health facilities, medical insurance systems, etc.). According to the theory of resource substitution, when rural youth are disadvantaged in terms of access to public medical resources, they will rely more on social capital resources. Thus, social capital resources are likely to have a greater impact on the mental health of rural youth. Therefore, the following research hypothesis is proposed:

> *Hypothesis 3*: the effect of social capital on the mental health of rural youth is greater than that of urban youth.

3 Method

3.1 Data

An online survey was carried out via the data collection platform "Researcher," a professional online survey tool developed by Hanyi Data Technology (Shenzhen) Co., Ltd. Its sample frame has 30,000 of the most active WeChat users in Chin's urban and rural areas, with an average age of 30, and has been applied in several scientific research projects. The survey was continuously pushed online from August 27 to August 30, 2020. The questionnaire was randomly sent according to a male-to-female ratio of 1:1. The respondents received and answered the questionnaires through WeChat software on their mobile terminals. To ensure data quality, we set each IP address to submit only one questionnaire, and utilized technical means to screen out invalid questionnaires, such as robot answering. We received 1936 valid samples. The samples

were distributed in 32 provinces, autonomous regions and municipalities directly under the Central Government, except for Tibet and Macau.

3.2 Measures

3.2.1 Personal information

We gathered personal information such as gender (male and female), age, marital status (married and unmarried), religious belief (yes and no), residence, and Chinese Communist Party (CCP) membership. For residence, respondents were asked if they lived in an urban or rural community at the time of the survey. In Western countries, political party affiliation is a personal choice and related to social-political values. In China, research has shown that CCP members are a selective group of elites and quasi-elites.

3.2.2 Mental health

Participants' mental health during the epidemic was assessed using the Brief Symptom Inventory-18 (BSI-18). The BSI-18 is an 18-item self-report scale of statements that participants respond to based on their level of distress over the preceding seven days (a 5-point Likert-like scale from 0, not at all, to 4, extremely). For convenience, this study converted scores. The higher the final score, the better the mental health.

3.2.3 Socioeconomic status

Many scholars have measured socioeconomic status using a combination of income, education and occupation, which this study also uses. Income is the annual household income of the respondent in the past year; education is the number of years of the respondent's education; and occupation is divided into five levels from low to high. Factor analysis was done on these three variables, and a common factor representing social and economic status was extracted. The factor contribution rate was 52.83%. For convenience, this study transformed it into a score with a range of values from 1 to 100 (25). The higher the score, the higher the socioeconomic status.

3.2.4 Social capital

Social capital, including bonding social capital and bridging social capital (19), was extracted using five questions from the questionnaire: harmony of marital relationships, harmony with other family members, the frequency of online communication with relatives and friends, the frequency of internet usage, and the number of people contacted daily. Two common factors were extracted, with a cumulative contribution rate of 60.54%. The first common factor represents bonding social capital, which is composed of harmony of marital relationships and harmony with other family members. A higher value of this variable indicates a higher level of personal social engagement. The second common factor represents bridging social capital, composed of harmony with other family members, the frequency of online communication with relatives and friends, the frequency of internet usage, and the number of people contacted daily. The higher this variable's value, the greater the extent of communication with other groups. For convenience, the values of both common factors are transformed to a range of 1–100, where higher scores represent more social capital.

3.2.5 COVID-19 severity

COVID-19 is measured by whether infected or dead people are in the community. A community without infection and death is considered not serious with a value of 0. The presence of an infected person or death in the community is considered serious and assigned a value of 1.

3.3 Data analysis

Data analysis was performed using STATA version 17. Continuous variables were summarized as means ± standard deviation (SD); while categorical variables were summarized using frequency and percentages. Mental health is a continuous variable, and this paper mainly uses the ordinary least squares regression (OLS) model to estimate it. Firstly, based on controlling demographic variables, a multiple linear regression model was constructed to compare the differences between urban and rural youth mental health. According to epidemic severity, a sub-sample regression analysis was conducted to discuss the differences between urban and rural youth mental health. Finally, an interaction model of residence and socioeconomic status, residence and social capital was further established to test separately whether there were differences between urban and rural in the effects of socioeconomic status and social capital on youth mental health.

4 Results

4.1 Demographic characteristics and background

Our analysis was based on 1,936 validated questionnaires. The average age of the sample was 27 years, with 49% of the male sample and 26% of the youth living in rural areas. About 34% of the respondents had a severe epidemic level in their community at the time of the survey. The mean value of the mental health level is 82.32 and the standard deviation is 9.98 (Table 1).

4.2 The impact of the COVID-19 on urban and rural youth mental health

Table 2 shows the analysis results of the multiple linear regression model for urban and rural youth mental health. The variable coefficient of the epidemic's severity was negative and significant in the full-sample model, which means that the mental health level of youth in areas with severe epidemics was lower than that of youth in areas with less severe epidemics. The rural youth level of mental health was 0.89 units higher than urban youth, indicating the unique stressor of the COVID-19 pandemic has a significantly more negative impact on the mental health of urban youth compared to rural youth. This negative effect diminishes the resource advantage of urban youth in coping with the COVID-19 pandemic.

Did rural youth have higher levels of mental health than urban youth at any time during the pandemic? To answer this question, a sub-sample analysis was conducted based on the severity of the epidemic in the community where the youth lived. When the

TABLE 1 Participant demographics.

Variable	Variable assignment	*N*	Mean value	SD
Gender	Male = 1, Female = 0	1936	0.49	0.50
Age	15–40	1936	26.71	5.73
Marital status	Married = 1, Unmarried = 0	1936	0.70	0.46
CCP membership	Yes = 1, No = 0	1936	0.17	0.38
Religious belief	Yes = 1, No = 0	1936	0.15	0.35
Mental health	26–90, The larger the value, the healthier it is	1936	82.32	9.98
Residence	Rural = 1, Urban = 0	1936	0.26	0.44
COVID-19 Severity	Severe = 1, Not severe = 0	1936	0.34	0.47
Socioeconomic status	1–100, The larger the value the higher the socioeconomic status	1936	58.43	16.15
Bonding social capital	1–100, The larger the value, the more bonding social capital	1936	65.79	15.46
Bridging social capital	1–100, The larger the value, the more bridging social capital	1936	81.05	8.63

TABLE 2 Multiple linear regression analysis of the impact of the COVID-19 on urban and rural youth mental health.

	Full sample		Sample of less severe epidemic		Sample of severe epidemic	
	B	*p*-value	*B*	*p*-value	*B*	*p*-value
COVID-19 Severity	−3.35 (0.474)	0.000***	/	/	/	/
Residence	0.89 (0.501)	0.049*	1.38 (0.557)	0.013*	−0.93 (1.141)	0.416
Gender	0.03 (0.444)	0.947	−0.17 (0.493)	0.734	0.58 (0.882)	0.511
Age	0.16 (0.043)	0.000***	0.15 (0.047)	0.002**	0.22 (0.089)	0.015*
Marital status	1.08 (0.534)	0.042*	2.13 (0.573)	0.000***	−1.92 (1.156)	0.097
Religious belief	−1.93 (0.636)	0.003**	−0.17 (0.768)	0.827	−4.12 (1.111)	0.000
CCP member	0.86 (0.603)	0.153	0.71 (0.701)	0.313	1.45 (1.107)	0.192
Satisfaction with the control of the epidemic	3.94 (0.789)	0.000***	3.64 (0.867)	0.000***	5.29 (1.617)	0.001**
Constant	74.76 (1.364)	0.000***	74.37 (1.467)	0.000***	71.24 (2.843)	0.000***
N	1936		1,280		656	
Adj-R^2	0.060		0.050		0.048	

Standard error in parentheses; *$p < 0.05$, **$p < 0.01$, and ***$p < 0.001$. Dummy variables: Gender (male = 1, female = 0); Residence (rural = 1, urban = 0); Marital status (Married = 1, unmarried = 0); and the remaining dummy variables (yes = 1, no = 0).

pandemic was less severe, the perceived pressure of the COVID-19 pandemic was higher among urban youth than rural youth, leading to higher mental health levels among rural youth compared to urban youth. When the pandemic was more severe, there was no longer a difference in the mental health levels between urban and rural youth.

4.3 Influence of socioeconomic status and social capital on the mental health level of youth: urban and rural differences

Table 3 reports the results of a multiple linear regression of the effects of socioeconomic status and social capital on youth mental health during the COVID-19 epidemic. In the full model, socioeconomic status variable shows that for every one-unit increase in socioeconomic status, there was a 0.04-unit improvement in the mental health of urban and rural youth. Both variables of social capital-bonding social capital and bridging social capital-contributed positively to the mental health of urban and rural youth. The regression coefficient of the residence variable was 1.32 and passed the significance test, indicating the mental health of rural youths was better than that of urban youths after controlling for other variables.

With age increase, the mental health level of urban and rural youth rose. The mental health level of married youth was lower than that of unmarried youth. The epidemic control satisfaction variable shows that satisfaction with local epidemic control measures helped urban and rural youth improve their mental health.

To test the difference between urban and rural in the effectiveness of two supportive resources, socioeconomic status and social capital, on youth health, Table 3 continues constructing the interaction model

TABLE 3 Urban–rural differences in the impact of socioeconomic status and social capital on youth mental health levels.

	Full Model		Interaction model between residence and socioeconomic status		Interaction model between residence and social capital	
	B	*p*-value	*B*	*p*-value	*B*	*p*-value
Socioeconomic status	0.04 (0.015)	0.008**	0.07***(0.018)	0.000***	0.04 (0.015)	0.008**
Bonding social capital	0.19 (0.016)	0.000***	0.19***(0.016)	0.000***	0.19 (0.018)	0.000***
Bridging social capital	0.11 (0.025)	0.000***	0.11***(0.025)	0.000***	0.12 (0.031)	0.000***
Residence	1.32 (0.512)	0.010*	6.02 (1.693)	0.000***	6.15 (4.550)	0.177
Residence* socioeconomic status	/	/	−0.09 (0.030)	0.004**	/	/
Residence*Bonding social capital	/	/	/	/	−0.03 (0.031)	0.390
Residence*Bridging social capital	/	/	/	/	−0.04 (0.052)	0.462
COVID-19 Severity	−3.29 (0.457)	0.000***	−3.28 (0.456)	0.000***	−3.31 (0.458)	0.000***
Gender	−0.38 (0.428)	0.369	−0.43 (0.428)	0.315	−0.39 (0.428)	0.368
Age	0.09 (0.044)	0.030*	0.09 (0.044)	0.036*	0.09 (0.044)	0.031*
Marital status	−1.56 (0.571)	0.006**	−1.56 (0.570)	0.006**	−1.56 (0.571)	0.006**
Religious belief	−2.10 (0.611)	0.001**	−2.11 (0.610)	0.001**	−2.10 (0.612)	0.001**
CCP member	−0.09 (0.593)	0.885	−0.18 (0.592)	0.765	−0.12 (0.594)	0.845
Satisfaction with the control of the epidemic	1.68 (0.778)	0.031*	1.69 (0.777)	0.030*	1.70 (0.779)	0.029*
Constant	57.22 (2.465)	0.000***	55.51 (2.529)	0.000***	55.44 (2.982)	0.000***
N	1936		1936		1936	
Adj-R^2	0.130		0.133		0.135	

Standard errors are in brackets; *$p < 0.05$, **$p < 0.01$, and ***$p < 0.001$. Dummy variables: Gender (male = 1, female = 0); Residence (rural = 1, urban = 0); Marital status (Married = 1, unmarried = 0); and the remaining dummy variables (yes = 1, no = 0).

between residence and socioeconomic status and the interaction model between residence and social capital. The reason for constructing an interaction model instead of directly comparing coefficients from separate urban and rural subsamples is to avoid sample selection bias caused by population mobility between urban and rural areas and estimation errors resulting from differences in sample sizes (26).

Firstly, the results of the interaction model between residence and socioeconomic status are shown in Table 3. The interaction term between residence and socioeconomic status is negative and passes the significance test, indicating that the contribution of socioeconomic status to rural youth mental health is less than that of urban youth. It indicates that during the pandemic, urban youth have become more dependent on their socioeconomic status compared to normal social conditions. This may be attributed to the nature of COVID-19 as a highly contagious disease. In urban areas, both high and low-status youth need to venture outside, interact with people, and may even enter the labor market to survive, thereby facing the risk of contracting COVID-19. The higher the economic status of urban youth, the more likely they are to have access to protective and subsistence materials, and the more likely they are to be employed in jobs with a low risk of unemployment and high returns, and thus better protected against the risk of COVID-19. On the other hand, urban youth with lower socioeconomic status experience greater pressure during the pandemic and are more prone to developing mental health issues. Rural youth's income sources include agricultural income and non-agricultural income. Agricultural income mainly comes from contact with land and crops, but less contact with people, so the possibility of contracting COVID-19 is low. Non-agricultural income is more obtained through non-agricultural work, which inevitably involves contact with people and leads to a higher possibility of contracting COVID-19. Those groups in rural areas with high socioeconomic status are mostly those with non-agricultural income and are more likely to be infected with COVID-19 than those with low socioeconomic status. So, while high social status in rural areas increases the ability of rural youth to cope with COVID-19, it is also high social status that puts them at higher risk of contracting COVID-19.

Then there is also the interaction model between residence and social capital. It can be seen that the interaction term coefficient between residence and bonding social capital is negative but fails the significance test, and the interaction term coefficient between residence and bridging social capital is negative and also fails the significance test, which means that there was no difference between urban and rural areas regarding the contribution of bonding and bridging social capital to youth mental health.

5 Discussion

The COVID-19 pandemic created a public health crisis on an unprecedented scale, affecting everyone psychologically, although to different extents. This study used WeChat user survey data to analyze the mental health status of young people under the age of 40 and explored the role played by China's unique urban–rural dual system in this crisis.

We found the mental health of rural youth was better than that of urban youth during the COVID-19 pandemic. Although this contradicts previous research conclusions before the epidemic, it confirms our research hypothesis 1. This indicates that the negative impact of this stressor, COVID-19, on the mental health of urban youth is significantly higher than that of rural youth. This negative impact undermines the resource advantage of urban youth in coping with the COVID-19 pandemic, mainly because rural areas have lower population density and more dispersed living conditions. Virus transmission is less likely in such conditions than in large-scale population gatherings and high mobility in urban areas. However, this situation Icured in communities where the epidemic was not severe. When an epidemic becomes severe, there is no longer a difference in the mental health levels between urban and rural youth.

During the COVID-19 period, we found that the promotion effect of socioeconomic status on the mental health of urban youth was greater than that of rural youth. This is a provocative finding because the resource substitution theory posits that urban youth have better access to public resources, and the effect of socioeconomic status on their mental health should be weaker than that of rural youth. However, the reality was quite the opposite. This may be determined by the characteristics of COVID-19 as a large-scale infectious disease. Some research indicates that while maintaining social distancing is important to prevent virus transmission, it is difficult to implement in some occupations (27) there are mainly concentrated in urban areas. In urban areas, high-status and low-status youth face the same risk of virus infection, but high-status youth resist the risk of virus infection better than low-status youth (28). Rural areas present a different scenario. The income sources of rural youth include both agricultural and non-agricultural income. Agricultural income is mainly related to land and crops, less contact with people, and lower likelihood of contracting COVID-19, while non-agricultural income is obtained through non-agricultural work, inevitably involving contact with people and thus a higher likelihood of COVID-19 infection. In rural areas, those with high socioeconomic status are often groups with non-agricultural income who (29), are more likely to contract COVID-19 than those with low socioeconomic status. Therefore, in rural areas, high socioeconomic status may enhance the ability of rural youth to cope with COVID-19, but it also exposes them to a higher risk of contracting the virus due to their high socioeconomic status.

Both variables of social capital, bonding social capital and bridging social capital, have a positive promotion effect on the mental health of urban and rural youth. Bonding social capital includes relationships such as marital and familial ties, measuring the closeness of interaction between urban and rural youth and their core network members during the epidemic period. This close connectivity is an important source of social support for urban and rural youth, enhancing their levels of mental health. Bridging social capital includes acquaintances outside intimate circles, online networks, and avenues through which people exchange information, constituting a network for individuals to obtain external support. This helps urban and rural youth maintain connections with the outside world, enabling them to promptly receive diverse information about the COVID-19 epidemic, further promoting mental health. Additionally, the promotion effect of social capital on urban and rural youth mental health does not differ. Despite urban areas being markedly superior to rural areas in terms of medical and health facilities and healthcare systems, urban youth did not rely less on social capital resources during the epidemic period simply because they have more public resources than rural youth. This partly indicates that advantaged groups do not weaken their dependence on a particular resource despite having access to multiple resources when faced with risks.

The above findings imply that although the impact of the COVID-19 pandemic on the mental health of urban and rural youth still follows the logic of health inequality, meaning that during the pandemic, groups with higher socioeconomic status have better mental health. However, when considering urban and rural areas separately, the mental health of urban youth is not higher than that of rural youth, especially in regions with less severe local epidemic. This is primarily due to the large-scale population aggregation and high mobility in urban areas, which intensify the spread of the COVID-19 virus, resulting in higher levels of risk for urban youth, particularly those with lower socioeconomic status. This highlights the need to pay attention to the mental health of urban youth with lower socioeconomic status during the pandemic.

In addition, bonding social capital, characterized by the close interaction of a core relationship circle, and bridging social capital, mainly characterized by the transmission of heterogeneous information, play an important role in enhancing the level of mental health of urban and rural youth during an epidemic. Therefore, the cultivation of social capital of urban and rural youth should be strengthened under the current situation of normalization of epidemic prevention and control.

This study compares the differences in the mental health of urban and rural youth during the COVID-19 epidemic, and analyses the differences in the effects of two factors, socioeconomic status and social capital, on the mental health of youth between urban and rural areas, but there are some shortcomings in this study. Firstly, Due to the limitations of online surveys, all the data obtained in this study are from WeChat users, which may lead to sample bias as it does not include young individuals who do not use WeChat. This raises concerns about the generalizability of the research findings. Secondly, the study found that urban youth had lower mental health compared to rural youth due to higher exposure to COVID-19 pandemic-related stress during the pandemic. However, stress exposure remains theoretical in the paper, and more rigorous data is needed to support this claim. Lastly, the study revealed that the effect of socioeconomic status on the mental health of urban youth is greater than that of rural youth, while the effect of social capital on urban and rural youths' mental health does not differ. The inconsistent performance of socioeconomic status and social capital as influencing factors on the mental health of urban and rural youth requires further analysis.

6 Conclusion

Health inequality that altered between urban and rural residents during COVID-19 was examined, with rural youth exhibiting better levels of mental health than urban youth in areas where the epidemic was not severe. The impact of socioeconomic status and social capital on urban–rural health inequality was examined and found not to follow the resource substitution theory, i.e., advantaged groups do not

weaken their dependence on a particular resource despite having access to multiple resources when encountering risks.

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 humans were approved by the Scientific and Ethical Review Committee of Shaanxi Normal University (No. 202002001). The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study. Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

Author contributions

YX: Writing – original draft, Writing – review & editing.

Funding

The author(s) declare that financial support was received for the research, authorship, and/or publication of this article. This work was supported by the Humanities and Social Science Research Fund of the Ministry of Education [grant number 19YJC840047].

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.

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frontiers | Frontiers in Public Health

TYPE Original Research
PUBLISHED 24 May 2024
DOI 10.3389/fpubh.2024.1387494

OPEN ACCESS

EDITED BY
Chong Chen,
Yamaguchi University Graduate School of Medicine, Japan

REVIEWED BY
Isain Zapata,
Rocky Vista University, United States
Wiam Elshami,
University of Sharjah, United Arab Emirates

*CORRESPONDENCE
Tai Metzger
✉ taimetzger@g.ucla.edu

†These authors share first authorship

RECEIVED 17 February 2024
ACCEPTED 01 May 2024
PUBLISHED 24 May 2024

CITATION
Metzger T, Nguyen N, Le H, Havo D, Ngo K, Lee S, Nguyen T, Nguyen Q, Tran L, Tong N, Le C and Dudovitz R (2024) Does volunteering decrease burnout? Healthcare professional and student perspectives on burnout and volunteering.
Front. Public Health 12:1387494.
doi: 10.3389/fpubh.2024.1387494

Does volunteering decrease burnout? Healthcare professional and student perspectives on burnout and volunteering

Tai Metzger[1,2*†], Nathan Nguyen[1†], Hillary Le[1], Daisy Havo[1], Katherine Ngo[1], Sebastian Lee[1], Timmy Nguyen[1], Quynhanh Nguyen[1], Leyna Tran[1], Nathan Tong[1], Collin Le[1] and Rebecca Dudovitz[3]

[1]Vietnamese Community Health Project, University of California-Los Angeles, Los Angeles, CA, United States, [2]Oakland University William Beaumont School of Medicine, Rochester, MI, United States, [3]Division of General Pediatrics, Department of Pediatrics, David Geffen School of Medicine at UCLA, Los Angeles, CA, United States

Background: Burnout among healthcare providers is a significant crisis in our healthcare system, especially in the context of the COVID-19 pandemic. The aim of this study was to understand what motivates healthcare workers and students to volunteer in their community as well as examine how volunteering relates to burnout. These findings can help health organizations better meet the needs of healthcare workers, as well as provide insights for non-profits that rely on volunteer professionals.

Methods: Healthcare providers ($N = 8$), graduate healthcare students ($N = 10$), and undergraduate students ($N = 14$) who volunteered at community health fairs completed the OLBI burnout assessment and an individual semi-structured interview to characterize their attitudes toward volunteering and its relationship with burnout. Interviews were recorded, transcribed, and analyzed using a phenomenological approach, comparing themes across levels of burnout among providers and students.

Results: Participants described that feeling burnt out decreased one's likelihood to volunteer, but also that volunteering prevented burnout. The OLBI scores showed that 79.2 and 20.8% of students were low and moderately burnt out respectively, and 87.5 and 12.5% of health professionals were low and moderately burnt out, respectively. Students volunteered for professional development while healthcare professionals cited a desire for a change in their day-to-day work as a reason to volunteer. Both students and health professionals often volunteered because they wanted to make a difference, it made them feel good, and/or they felt a responsibility to volunteer. COVID-19 had a wide range of effects on burnout and motivations to volunteer.

Conclusion: Volunteering may be useful for preventing burnout among healthcare workers and students, but may not be helpful for those already experiencing burnout. Interview responses and the fact that none of the volunteers had high burnout levels according to their OLBI scores suggest those who choose to volunteer may be less burnt out. Healthcare organizations and schools can encourage volunteering by emphasizing the difference healthcare students and professionals can make through volunteering in the community. Increasing convenience and emphasizing professional development can help recruit and retain healthcare student volunteers. Highlighting the chance

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to diversify their scope of practice may help recruit and retain healthcare professional volunteers.

KEYWORDS

COVID-19, volunteering, burnout, community health, medical education, physician shortage, mental health

Introduction

Studies have shown that over 90% of physicians report community participation and promoting health within the community as an important part of their profession (1). However, only 39% of physicians volunteer in this role in a given year (2). Meanwhile, many low-income communities and organizations that serve them depend on volunteer healthcare providers. Understanding what motivates physicians to volunteer is critical to sustaining these efforts.

At the same time, physician burnout is a major problem in our healthcare system, with 62.8% of physicians experiencing burnout (3). It has been shown that burnout often begins during clinical rotations and does not improve throughout or after training (4). Moreover, the COVID-19 pandemic has exacerbated burnout rates and led to staff shortages throughout the United States (5). Despite the extensive research on this topic, solutions to this burnout crisis are not clear (6). While several studies have examined interventions to prevent burnout, volunteering has generally not been considered (7, 8). Moreover, some studies have been done on healthcare students or professionals' motivations to volunteer, but they do not investigate combating burnout as a potential reason for volunteering. For example, one survey of 286 medical schools in Brazil found that 44% of students volunteered for altruistic reasons, with the others either volunteering as a result of personal duty or academic interests (9). Additionally, in Poland, many students viewed volunteering as part of their civic duty, yet felt unprepared for the staff shortages and heavy workload of the pandemic (10). Thus, altruism may be one lens through which to view the role and effect of volunteering.

A handful of studies document how global health volunteering, including short-term volunteer experiences abroad, might prevent burnout, but we lack an understanding of how local, long-term volunteer experiences relate to burnout (11, 12, 13). In regards to medical students, a 2023 study concluded that global health outreach experiences could potentially reduce burnout (13). One physician volunteer program in Canada reports that younger physicians are easier to recruit as compared to mid-career physicians (14), but few studies have examined how the motivations for volunteering and the role of burnout vary for students who are still in training versus healthcare professionals who have completed training. Given the strain on healthcare workers amid the pandemic, this study delves deeper into their motivations for volunteering and their perception of the role volunteering plays in combating burnout.

To expand on the breadth of the current literature, we included both healthcare students and healthcare professionals, from a variety of fields, such as nursing, medicine, and dentistry. We chose to include healthcare professionals and students from a variety of healthcare fields because past studies on burnout and volunteering have predominantly focused on physicians and to a lesser extent medical students (1, 2, 3, 8, 9, 10, 13, 14). Including more diverse perspectives allowed us to contribute more novel findings to the literature as well as potentially make comparisons between groups. Volunteering was defined as providing free services to a community nonprofit organization offering free healthcare to underserved populations. We sought to characterize student and healthcare professional perspectives on their motivation and attitudes regarding volunteering at local, community-based health fairs, and the relationship between volunteering and burnout.

In summary, the goal of our study was to provide insights about burnout, volunteering, and their relationship from the perspective of students and professionals from various healthcare fields.

Materials and methods

Vietnamese Community Health (VCH) at the University of California, Los Angeles (UCLA) is a nonprofit that provides free health screenings and services to underserved, predominantly Vietnamese American and Latine, patients through health fairs and other health education and outreach programs. In addition to UCLA undergraduate student volunteers, VCH recruits volunteers from various health professions, including physicians, nurses, pharmacists, chiropractors, and others, as well as students in various health professional schools (e.g., dental). We conducted a concurrent mixed methods study of healthcare professionals and students at various levels of education who chose to volunteer at VCH health fairs. We used both qualitative and quantitative data to describe the perceptions and experiences of the participants in a relatively little-studied area of research (15). Google Sheets and Google Docs were used for qualitative and quantitative analysis. All methods were carried out in accordance with local guidelines and the Declaration of Helsinki. This study was reviewed by the UCLA Human Research Protection Program (OHRPP) and was determined to meet the criteria for exemption from full IRB review on December 15, 2022 (IRB#22–000893).

Participants

Physicians, medical students, nurses, nursing students, optometrists, optometry students, dentists, dental students, pharmacists, pharmacy students, chiropractic students, acupuncture clinicians, acupuncture students, and pre-health undergraduate students who volunteered at at least one VCH health fair were invited to participate in the study. Participants were contacted via email by a member of the study team or were approached in person at a health

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fair. Eligibility criteria included having volunteered at one or more health fairs in the past 5 years and being a healthcare professional, healthcare student, or pre-health undergraduate student. All participants were entered into a raffle for four $25 Amazon gift cards. To avoid pressure on volunteers to participate in the study, all potential participants were assured that their participation was completely optional and would not impact their relationship with VCH. We sought to interview participants working in a variety of healthcare fields and in various stages of schooling. Recruitment continued until saturation of major themes and theoretical sufficiency were reached (16, 17).

Procedure

Data collection occurred from June to December of 2022. Data analysis began in October of 2022 and continued until May of 2023. All potential participants were provided with an information sheet in-person or via email outlining the study methods and goals, as well as potential risks and benefits of participation. The information sheet also included assurances that data would be kept password protected until being permanently deleted after study completion, and that other than the interviews themselves, all data would be de-identified. Only research team members had access to the study documents. After receiving confirmation that participants were interested, participants were scheduled for an interview. Before starting the interview, a member of the research team introduced the study to participants, answered any questions about the study, confirmed eligibility, and obtained oral consent.

After giving oral consent, each participant completed a brief demographic survey and the validated Oldenburg Burnout Inventory (OLBI) assessment to determine their level of burnout (18), which took about 10–15 min to complete in total. The survey and assessment were taken online and were anonymous. This OLBI assessment consists of 16 questions in which respondents select from "Strongly Disagree" (+4), "Disagree" (+3), "Agree" (+2), and "Strongly Agree" (+1). Respondents are classified as "low burnout" if their total is below 44, "moderate burnout" if their total is between 45 and 59, and "high burnout" if their total is 60 or above. "Exhaustion" and "Disengagement" subtotals are calculated as well (19). The OLBI has been accepted to be a reliable and valid measure of burnout in both work and academic settings (20). Participants then completed an individual semi-structured interview via Zoom video conferencing. Interviews lasted 20–60 min and were audio-recorded and transcribed for further analysis.

The interview guide (Table 1) included questions regarding participants' motivations for volunteering, their experience with burnout, and the impact of burnout and the COVID-19 pandemic on their attitude toward volunteering. Interviews continued until thematic saturation was achieved for both healthcare professionals and students. Themes were continuously identified from the interview transcripts by selected members of the team using a 3-step coding process. Saturation was determined to be complete when subsequent interviews revealed no new codes.

TABLE 1 Interview discussion topics and suggested interview questions.

Discussion topic	Interview questions
Motivations to volunteer	What makes you choose to volunteer at a Health Fair? Probe: What do you get out of volunteering? Probe: What can make your volunteer experience more fulfilling? Probe: How does volunteering at a Health Fair affect your perspective of healthcare?
Effects of the COVID-19 pandemic and burnout on motivation to volunteer	How has the pandemic affected your attitudes toward volunteering? What role does burnout or emotional exhaustion caused by your career play in your decision to volunteer? How do you combat burnout? How has the pandemic affected your attitudes toward burnout?
Effect of role in healthcare on motivation to volunteer	*If a student:* How does your role as a student affect your attitude toward volunteering? Probe: How do you expect your attitude toward volunteering to change after you graduate and work as a healthcare professional? Probe: What do you think could be done to encourage more students to volunteer? *If a healthcare professional:* How does your role as a healthcare professional affect your attitude toward volunteering? Probe: How is your attitude toward volunteering different now compared to when you were a student? Probe: What do you think could be done to encourage more healthcare professionals to volunteer?
Open-ended discussion	Is there anything else you would like to share regarding the personal impact volunteering has had on you, in general or during the pandemic?

Data analysis

Throughout the interview process, interviewers met to discuss emerging themes and develop and refine the codebook.

Qualitative analysis was conducted using a 3-step coding process based on grounded theory and thematic analysis (21). Three coders reviewed transcripts and coded them using the codebook. They discussed and refined the codes until a Kappa greater than 0.8 was achieved for all major codes. Personal opinions, beliefs, and judgments of the coders were omitted as much as possible when coding the interview transcripts in order to ensure reliable results. Interviews were then divided among the coders to complete the coding process. The analytic team then discussed and identified connections between codes and themes that emerged. Perspectives on volunteering were compared across levels of training and burnout levels.

The quantitative data from the OLBI assessment and demographic survey were also analyzed using unpaired t-tests to describe our sample and compare differences between groups. Burnout levels were compared across levels of training, sex, age, and country of birth.

Results

Overall, 32 interviews were conducted with 14 undergraduate students, 10 graduate healthcare students, and 8 healthcare professionals. Summaries of participant demographics and main themes with representative quotations can be found in Tables 2 and 3

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TABLE 2 Participant demographics.

	Undergraduate volunteer (*N* = 14)		Graduate healthcare student (*N* = 10)		Healthcare professionals (*N* = 8)	
	Number	Percent	Number	Percent	Number	Percent
Age						
18–24	14	100%	5	50%	0	0%
25–34	0	0%	4	40%	1	12.50%
35–44	0	0%	0	0%	0	0
45–54	0	0%	1	10%	3	37.50%
55 or older	0	0%	0	0%	4	50%
Sex						
Male	7	50%	4	40%	4	50%
Female	7	50%	6	60%	4	50%
Race/Ethnicity						
Asian/Pacific Islander	14	100%	5	50%	7	87.50%
Non-Hispanic White	0	0%	3	30%	1	12.50%
Asian/Pacific Islander and Non-Hispanic White	0	0%	3	10%	1	0%
Hispanic	0	0%	1	10%	0	0%
Born in the US						
Yes	13	92.90%	9	90%	3	78.10%
No	1	7.10%	1	10%	5	21.90%
Average OLBI Scores						
Disengagement Subtotal	18.57		16.1		15.38	
Exhaustion Subtotal	21.07		22		15.25	
OLBI Total Score	39.64		38.1		30.63	

respectively. Our interviewees' ages ranged from young adults (18–24) mainly for undergraduate and graduate students to older adults (45-older) for healthcare professionals. The proportion of males to females was nearly equal, with 46.9% being males and 53.1% being females. The majority of our participants identified as Asian/Pacific Islanders and were born in the United States.

According to the OLBI Assessments that our participants completed, 79.2 and 20.8% of students were low and moderately burnt out respectively, and 87.5 and 12.5% of health professionals were low and moderately burnt out respectively. The standard deviation of student OLBI scores was 5.7 and the standard deviation of professional OLBI scores was 10.9, suggesting that there may be wider variance in levels of burnout among health professionals than health students. Women had a higher average total OLBI score than men ($p = 0.15$), students had a higher average total OLBI score than health professionals ($p = 0.07$), and those born in the United States (U.S.) had a higher average total OLBI score than those born outside the U.S. ($p = 0.27$), though no differences reached statistical significance. None of the participants had high levels of burnout. Due to the small sample size, these quantitative results are primarily presented to provide descriptive information about our sample (see Tables 4, 5).

Qualitative analysis revealed five main themes: motivations to volunteer, shared student perspectives on volunteering in the future, the bidirectional relationship between volunteering and burnout, facilitators and barriers to volunteering, and the effects of COVID-19 on volunteering and burnout. "Motivations to volunteer" refers to the reasons participants cited as making them desire to volunteer, such as professional development for students, diversifying their daily activities for professionals, and intrinsic feelings of responsibility felt by both students and professionals. "Shared student perspectives on volunteering in the future" reflected how students predicted what their volunteering would look like after completing their training. For instance, many students stated that they expected to continue volunteering in the future because they would be able to make more of a difference after completing more training. "The bidirectional relationship between volunteering and burnout" refers to participant descriptions of how burnout decreased motivation to volunteer while volunteering protected against developing burnout. "Facilitators and barriers to volunteering" describes the factors that would make participants more or less likely to engage in volunteering, such as flexibility being a facilitator and inconvenient locations being a barrier. "The effects of COVID-19 on volunteering and burnout" refers to the role of the COVID pandemic as either increasing or decreasing feelings of burnout as well as enhancing or reducing the likelihood of volunteering, depending on the individual. Within each of these overarching themes, sub-themes were established. The themes and

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TABLE 3 Themes and representative quotations from healthcare professionals and students.

Themes	Subthemes	Example quotes
Motivations to Volunteer	(1) Intrinsic motivations (Students and Professionals)	Pre-health student: "it's very satisfying to know … the work you put in has directly helped the world and you did it for free." Physician: "If I can encourage someone to take better care of their health, I feel that with my role as a healthcare professional with years of experience, hopefully, makes some sort of impact in the person's life." Optometry student: "I feel that…it's my responsibility" Student: "So It just makes me feel good. I mean like, it's exhausting but it makes you feel good." Nurse Practitioner: "It makes me feel good to be able to give back and to be part of educating people about their health"
	(2) Professional development (Students)	Pre-health student: "I volunteer at places because I believe in the mission…But at the same time…I know it's going to be on my resume or on an application." Pre-health student: "Volunteering can give a lot of experience clinically, so I think that's the main reason I volunteer at the Health Fairs because they are a good source of experience for me" Medical student: "I would not say that community health is one of my interests at the moment, but I am interested in matching to a good residency in the future. So, unfortunately, there are boxes to check, so to speak, and so getting involved in the community and showing involvement with people ranks very highly with programs." Pre-health student: "[I] want to volunteer more to put my knowledge and the thing I learn in class into practice." Pre-health student: "So I guess volunteering is a really good way to apply the things you learned." Pre-health student: "I enjoy…working with healthcare professionals, I feel like a lot of good insight they can give me, especially when it pertains to applying to med school and working as a physician. I feel like I have a lot to learn from them, so it's great that I can work so closely and get good advice from them"
	(3) Diversifying and expanding on their day-to-day work (Professionals)	Physician: "for the past you know 10 years my work has taken me away from direct contact with the community so it was a nice way to re-engage with the patient's um Vietnamese patients and also the students." Physician: "I enjoyed volunteering because it provides me with a change in daily activity."
	(4) Mentoring the next generation (Professionals)	Nurse Practitioner: "For me, it's to give my students the opportunity to volunteer. I think it's a good experience for them." Physician: "I participate in these kinds of activities because…it is great to see young people participating and being engaging…" Physician: "The desire to teach the next generation…"
Students shared similar perspectives on volunteering in the future	(1) Volunteer altruistically instead of for personal gain	Pre-health student: "Once I'm established as a professional, I think for me volunteering would become less of oh I want to do it for my resume and would become more like I want to do it just because I really care about this organization…And once we have gotten past all that and have become established as individuals within our career, we can really separate ourselves from the whole I need to do things pertaining to my field. Because at least for me personally, I would love to volunteer at more things unrelated to my field just because I'm interested in it."
	(2) Looking forward to being able to make more of a difference	Pre-health student: "As a healthcare professional, just being able to like do more for the patient…I feel like it could be more rewarding to like volunteer like that."
	(3) Try to volunteer in different settings outside of healthcare	Pre-health student: "I would say that like if I were to become a healthcare professional or like after graduation, I would say my attitude toward volunteering would still be largely the same, just like trying to help others. But maybe just find different avenues to help people like since I would already be a "healthcare professional," I could maybe volunteer at a soup kitchen or something like that."
The bidirectional relationship between volunteering and burnout	(1) Burnt out professionals and students are less motivated to volunteer	Pre-health student: "burnout is definitely real and it affects my decision to volunteer by making me less likely to want to volunteer." Pre-health student: "[burnout] acts as like a limiting factor so especially this quarter I really did not do as much hospital volunteering." Physician: "if people feel burnout they may not want to volunteer."
	(2) Volunteering combats burnout for both students and professionals	Pre-health student: "I think [volunteering] kind of helps the burnout because…it kind of reminds me of what I want to do in the future and like eases the burnout a little because when I'm doing school I'm not like you know seeing a lot of impact in the community." Nurse Practitioner: "…I think for me it actually combats burnout or emotional exhaustion …" Physician: "I think if you can help people and then they tell you that you are helping them tremendously, then you will not get burnout."

(Continued)

TABLE 3 (Continued)

Themes	Subthemes	Example quotes
Barriers and facilitators to volunteering	(1) Increasing convenience and accessibility	Pre-health student: "One of the things is how easy you guys make it. Because like if you do not have the transportation you will provide it. I think that is huge because otherwise a lot of people do not have that opportunity." Chiropractic student: "I think largely marketing. If you have posters or flyers that we could share with people, that would be pretty cool." Physician: "I think just make it more convenient for them"
	(2) Consideration of Individual Preferences	Pre-health student: "I think just being mindful of preferences I think is the biggest thing" Physician: "I think you do give people food…I thought it was good that you send out certificates and thank you notes"
	(3) Showing impact to foster intrinsic motivation	Optometry student: "Having patient testimonials, the reasons why they enjoyed it or things like that to see the benefit is appreciable and they can actually make an impact on these communities" Physician: "I think all of us have to work on telling [potential volunteers], "Hey even if you can even help one person, or teach one kid, or show that one kid direction, or show that one patient that hey, there's someone here who can at least listen to you for 5 min, I think you have done a lot."
	(4) Making Friends/Socialization	Pre-health student: "For me, the most important thing is probably just like making friends or making connections that I feel are really impactful for my life."
Effects of COVID-19 on volunteering and burnout	(1) The pandemic increased burnout for some individuals	Pre-health student: "I feel like the pandemic kind of magnified the effects of burnout." Nurse Practitioner: "In terms of burnout in general, the pandemic was a really difficult time."
	(2) The pandemic decreased burnout for some individuals	Pre-health student: "During the pandemic, I do not think I experienced as much burnout" Physician: "The pandemic rejuvenated or revived our attitudes and broke the monotony of our practice that may contribute to burnout for some people."
	(3) The pandemic decreased opportunities for volunteering, but increased motivation to volunteer	Pre-health student: "The pandemic definitely limited my opportunity and my time and access to more volunteer, but increased my need and want to volunteer more to make up for the lost time." Physician: "I had always had a strong sense of wanting to participate in activities…during the pandemic, when we were unable to do that, I felt that there were many people who needed us, but were not able to reach out."
	(4) Fear of spreading COVID-19 while volunteering	Chiropractic student: "You're going to be in a public space…there's a possibility that you get it from patient B if you are right next to them…The question is how do we do it [volunteer] as safely as possible?" Nurse Practitioner: "When the numbers were higher, I definitely did not want to volunteer."

TABLE 4 OLBI scores by sex.

	Men	Women
Disengagement Subtotal ($p = 0.50$)	16.5	17.4
Exhaustion Subtotal ($p = 0.09$)	18.2	21.4
OLBI Total Score ($p = 0.15$)	34.7	38.8

TABLE 5 OLBI score comparisons by demographic.

	Average OLBI total scores ± Standard deviation
Student Professional ($p = 0.07$)	39.0 ± 5.7 30.6 ± 10.9
Male Female ($p = 0.15$)	34.7 ± 7.1 38.8 ± 8.5
Born in US Born Outside ($p = 0.27$)	38.0 ± 6.0 32.9 ± 12.8

sub-themes are presented in Table 3. Each sub-theme represented a key finding related to its associated theme. Example quotes displaying each sub-theme have been provided in Table 3. While the main themes were present in all interviews, several sub-themes differed between students and professionals. Figure 1 encompasses the broad findings from these interviews. Representative quotations found in Table 3 and the following paragraphs provided insight into the qualitative data highlighting the perspectives of the participants in regard to burnout and volunteering.

Demographic characteristics did not appear to relate to noticeable differences in perspectives on volunteering and burnout.

Motivations to volunteer

Both students and health professional volunteers discussed their desire to make a difference for those in need as an important motivation for volunteering. As one student stated, "I also want to contribute some effort and time to help the community that is in need of help." This desire to make a difference was sometimes expressed as an obligation or responsibility to volunteer. For example, when asked why they

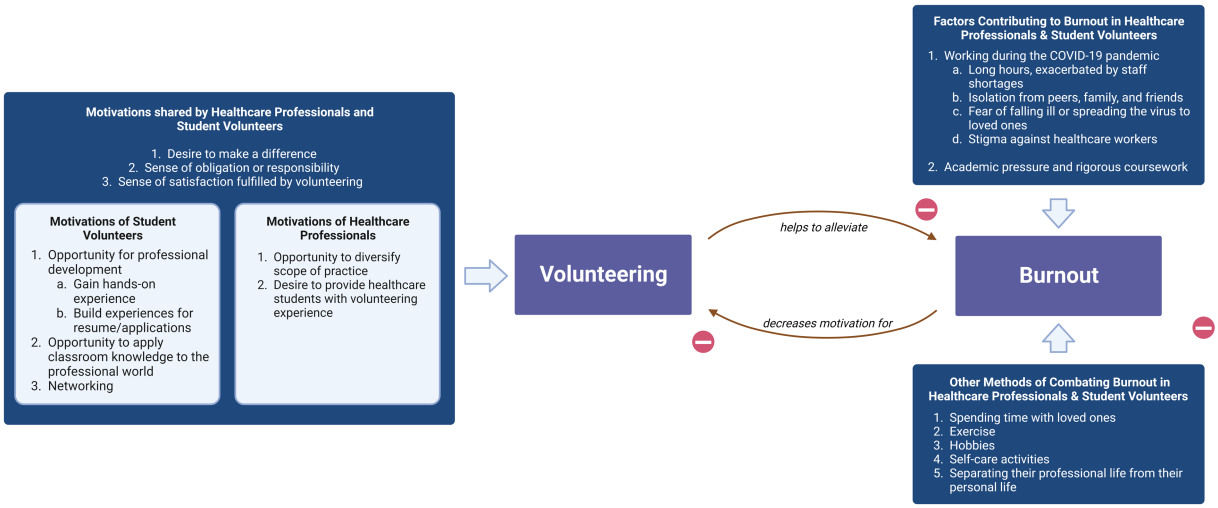

FIGURE 1
Healthcare professionals and student volunteers demonstrated a wide range of motivations to volunteer, commonly citing the desire to make a difference and their sense of obligation and satisfaction fulfilled through volunteering. Participants expressed that volunteering, amongst other factors, helped to alleviate burnout caused by the COVID-19 pandemic and by academic pressure. However, participants also indicated that burnout decreased their motivation to volunteer.

volunteer, one nurse answered, "As a healthcare professional and more specifically as a nurse, I think it's part of my responsibility to the community to be able to volunteer." In addition, participants described how volunteering and positively impacting others made them feel good or fulfilled. For example, an optometry student said they choose to volunteer because they "get a great feeling to help people."

There were some motivations specific to student volunteers. Students described volunteering for professional development. For instance, some interviewees wanted to gain hands-on experience in the healthcare field, while others explicitly stated that it would be useful for their resumes or applications. Similarly, some students mentioned that volunteering in a healthcare setting allowed them to apply what they learned in class to real-life situations, such as one student who said, "I chose to volunteer because I thought it was a good opportunity to practice my skills outside of school." Finally, a few students discussed volunteering in order to network with health professionals or older students.

In contrast, health professionals described volunteering because the experience provided a change in their normal day-to-day work, allowing them to diversify and expand on their usual scope of practice and career. One participant said, "I think that, out of the 9–5, the very routine kind of nature of optometry, for example, it's kinda nice to really reach out and you feel very good that you are helping the community, and you are normally, but it's outside your normal, everyday day-to-day same office, same place, same people." Additionally, several health professionals, particularly the preceptors overseeing their student volunteers, cited wanting to give their students more opportunities to gain experience through volunteering. They also found it inspiring to interact with future health professionals. One physician stated, "Seeing and watching how engaged the young people are, it gives me a good feeling and a lot of hope…I find that it is an extremely meaningful use of my time."

Lastly, while students tended to think that their attitudes and reasons for volunteering might change after becoming health professionals, most health professionals reported their attitude toward volunteering was similar to when they were students. Specifically, students expressed that they expected to be able to volunteer for more fully altruistic reasons rather than for gaining experience and that they looked forward to being able to make more of an impact through their volunteering when they completed their training. Some students also expressed interest in volunteering outside of healthcare in order to explore fields unrelated to their career goals.

Bidirectional relationship between volunteering and burnout

Participants described a complex and bidirectional relationship between burnout and volunteering, whereby being burnt out would make one less likely to volunteer, and volunteering reduced burnout when the volunteer did not already feel burnt out. For example, one volunteer said, "[Burnout] definitely makes me not want to volunteer because it takes up time of your personal life and when you already have a lot of work to do." Meanwhile, participants also described how volunteering helped both students and health professionals reinvigorate their motivation for pursuing a career in healthcare. One student said: "It makes me more connected to my goals of being a doctor because you are actually seeing healthcare in action and not just studying all day." Similarly, one physician volunteer said that volunteering helped "renew my interest in and remembering why I had gone into medicine in the first place." These themes were consistent across students and health professionals and across those with low versus moderate burnout scores.

Facilitators and barriers to volunteering

One method of incentivizing health professional and student volunteers is the convenience of and accessibility to volunteering opportunities. Transportation in particular was frequently noted as a barrier by students. Additionally, the consideration of individual

preferences was seen as a positive by student volunteers. Participants suggested showcasing the difference made by volunteering in the community to foster intrinsic motivation and encourage greater student and health professional participation in events. For example, one member suggested that previous volunteers "tell their story, and maybe show videos or show different forms of media of how this opportunity has impacted a patient's life because I feel you can only say so much, and you just have to hear it and, like, see it from someone." to help with recruitment. A healthcare professional explained, "hearing positive stories or success stories from the patients as a feedback to the caregiver can be very motivating for them to continue to show up."

Additionally, participants suggested socialization or making friends facilitated volunteer recruitment and retention. As one student volunteer stated, "when you volunteer you are in an environment working together either over multiple sessions or just for a longer amount of time, so that gives you more opportunity to get to know people." A significant barrier to volunteering for both students and health professionals was a lack of time or energy caused by work, studies, and/or other demands.

Effect of COVID-19 on burnout and volunteering

Participants reported a wide range of effects of the COVID-19 pandemic on burnout. For some individuals, the pandemic increased the amount of burnout, whereas for others, it had no effect or even a positive effect. One participant stated that "the pandemic definitely puts more strain on physicians and healthcare providers so it certainly can make burnout more challenging, more prevalent, [and] more prominent." Similarly in education settings "it was harder to connect with the students… [and] it was harder for them because they did not have each other to lean on" which made "burnout… a really big deal… during the pandemic." Across all settings, volunteers discussed how social isolation and the lack of in-person activities during the pandemic was a challenge that contributed to burnout.

In addition, many individuals described losing a sense of freedom and routine they were accustomed to. COVID-19 also introduced new sources of stress as individuals felt that "it's become a lot [easier] to get burned out" because [of the tension] around healthcare… [as] they are wondering if [they] have COVID."

In contrast, COVID-19 sometimes had opposite effects on individuals' feelings of burnout. For example, one provider described feeling a "sense of urgency that people's health were at risk and that [they] had to do something new." Additionally, another individual mentioned how they did not "feel burned out because…it was a lot slower during the pandemic."

The COVID-19 pandemic also had varying effects on the participants' decision to volunteer. For some, the heightened healthcare needs in the community prompted them to want to volunteer more once they were able to, such as one participant who stated, "The pandemic made me feel that once things were opening again, that there was really a strong need for being able to provide these services." Alternatively, concern about contracting COVID-19 deterred some participants from volunteering during the pandemic. Participants also generally wanted volunteering opportunities to return to pre-pandemic levels and hoped for a return to normalcy.

Discussion

Key findings

Our study had several key findings. First, the results suggested that while burnout is a barrier to volunteering, participants thought volunteering helped them avoid burnout. Rather than reducing burnout in individuals who feel emotionally exhausted or disengaged from their work, volunteering seems to be more effective at preventing these feelings from occurring in individuals who are at risk for–but not yet experiencing–burnout. In addition, healthcare professionals and students may have some different motivations for volunteering, but feelings of gratification and a sense of responsibility to the community remained consistent for both groups, as well as the desire to make a difference. Students specifically volunteered to gain experience and advance their professional goals, while health professionals cited a desire for experiences different from their daily work activities. Furthermore, burnout amidst the COVID-19 pandemic and transitioning out of the pandemic affected individuals differently with some choosing to volunteer to combat burnout while others became more reluctant to volunteer. This is the first study analyzing motivations for volunteering along with the role of burnout across training levels of healthcare professionals and students. Ultimately, these findings can guide healthcare organizations in combating burnout as well as recruiting and retaining volunteers.

Burnout and volunteering

The fact that none of the volunteers interviewed in this study had high levels of burnout is consistent with this reciprocal relationship between burnout and volunteering. Our findings are also consistent with studies regarding physician volunteering in global health settings suggesting physicians experienced gratification from being able to help patients with difficult circumstances and insufficient resources as well as from being able to contribute to teaching and learning opportunities during medical missions (22). In addition, volunteering on mission trips improved mental health and decreased burnout scores (11–13). Thus, our study suggests some of the benefits of international service trips are also present in local volunteering opportunities, which may be both more accessible and sustainable than global health programs.

Previous studies that examined motivations for volunteering within the healthcare community primarily focused on physicians, particularly in foreign countries. A study from 2017 found that many physicians volunteered due to "humanitarian and prosocial desires," and wanted to practice medicine in a setting without the stress and demands of their daily routines (23). Another study investigated the motivations of those who participated in short-term medical missions, sometimes referred to as "voluntourism," and concluded that personality is a major factor in one's decision to volunteer abroad (22). Our findings build on this work. By examining the relationship between volunteering and burnout more broadly and including a variety of health professionals and students, we provide a more holistic view of volunteering perspectives within the healthcare community. Our present study also allows a comparison between healthcare volunteering internationally versus locally, showing that similar benefits to the volunteers are present in both.

TABLE 6 Recommendations.

	For schools and healthcare organizations to decrease burnout:	For non-profit organizations and volunteer programs to retain and recruit volunteers
Recommendations:	• Provide volunteer opportunities for students and healthcare professionals to gain skills (students) and prevent burnout (students and professionals) • Do not pressure individuals suffering from burnout to engage in volunteering • For healthcare organizations, highlight the impact of the efforts made by staff by providing patient testimonials expressing appreciation • Increase opportunities for having personal connections with others	• Emphasize the concrete difference made by the organization's work • Advertise specific stories of how service recipients have been impacted positively by volunteering • For students, highlight professional and career skills development • For healthcare professionals, highlight the unique experiences available through volunteering • Include opportunities for creating friendships and connecting with others • Make volunteer opportunities flexible and convenient • Appeal to feelings of responsibility to specific communities in need

Based on the interview responses, we hypothesize several aspects of volunteering that may contribute to reduced burnout. First, it was clear that the participants were motivated by seeing the positive impact of volunteering on those in need. Presumably, many of the participants entered or are planning to enter the healthcare field due at least in part to a desire to improve the health of others. Thus, volunteering may reduce burnout by providing a clear reminder of their purpose and original desire to work in healthcare. This hypothesis is consistent with the Social Cognitive Theory of causes of burnout that posits that burnout could be due to doubts about one's effectiveness, ability to achieve goals, and lack of reinforcement for their work (24). Moreover, our findings support the Social Exchange Theory of burnout which states that the disconnect between the results from one's work and the efforts put into the work, as well as a lack of reciprocity, could lead to emotional exhaustion and burnout (24). Volunteering could alleviate the perceived lack of reciprocity and sense of impact when the recipients and hosting organization show their strong appreciation. This sentiment of desiring to know their service was valued was evident in the quotes highlighted previously.

The role of COVID-19

In addition, we build on previous findings by describing a wide variety of perceived effects of COVID-19 on volunteering and burnout. COVID-19 seemed to have increased burnout for some and decreased burnout for others, supporting the idea that the pandemic's influence on individuals' perceptions of burnout was diverse. The pandemic served as a facilitator for volunteering by reinforcing the acute need for healthcare professionals in some cases but acted as a barrier to volunteering in other cases by creating the fear of contracting and spreading the virus.

Limitations and future research directions

This study had some limitations. To begin, all of the undergraduate students we interviewed were from the University of California, Los Angeles (UCLA), and are from the same organization, Vietnamese Community Health (VCH), which limits the generalizability of our findings. The fact that none of the participants were found to have high levels of burnout also limits the study by preventing us from learning about the perspective of individuals with high burnout levels (although this may provide evidence that individuals with high levels of burnout are less inclined to volunteer). In addition, although participants were assured of confidentiality and de-identification of their interviews and OLBI results, responses may be limited by social desirability response bias, particularly with regards to feelings of burnout, which can be a personal subject, and motivations to volunteering (25). Lastly, the participants were disproportionately Asian/Pacific Islander, possibly reducing how representative these volunteers may be of the general student and healthcare worker populations.

Future research studies can address these limitations by exploring these findings in other geographic areas and demographic groups to expand generalizability. For more specific quantitative results, a larger sample size can be studied, allowing for better comparisons about burnout and volunteering between different demographic groups, levels of training, and healthcare fields. This would allow for a better understanding of the various motivating factors specific to different subgroups. Future studies can also study the effects of implementing the interventions recommended in Table 6.

Implications and recommendations

Despite these limitations, these findings have important implications that may be useful in combating burnout as well as recruiting and retaining volunteers. Specifically, healthcare organizations might consider promoting volunteering as a possible method of preventing burnout and exhaustion among their employees so that they can gain experiences outside of their usual work and rekindle their original motivations for entering the healthcare field by helping those in need. Universities and health professional schools might consider formally integrating volunteer experiences into curricula to both prevent burnout as well as to provide meaningful, educational, and professionally enriching experiences outside of the classroom. Since burnt-out individuals are less likely to volunteer, these volunteer programs should be implemented while the students or professionals are not feeling burnt out. In other words, volunteering may be an effective preventive method against burnout but a poor, or even counterproductive, intervention for those who are already experiencing burnout. As the first study of this kind exploring relatively novel concepts, this paper can provide a starting point for generating research questions for additional studies. Table 6 provides

a summary of proposed recommendations for healthcare organizations, schools, and volunteer programs.

Lastly, non-profit healthcare organizations that rely on volunteers might use these findings to recruit and retain health professionals and student volunteers. For health professionals, for example, it may be beneficial to emphasize the opportunity to gain experiences that professionals normally do not get in their typical practice, while for students, opportunities for professional development could be emphasized. Additionally, organizations should consider showcasing their impact through patient testimonials, make efforts to increase the convenience and flexibility of volunteering opportunities, and appeal to individuals' intrinsic motivation to volunteer by highlighting their responsibility to the community. Indeed, seeing that their volunteering directly made a difference in the lives of those in need was overall viewed as the most important factor in deciding to volunteer.

Data availability statement

The datasets presented in this article are not readily available because the main sources of data for this study were video interviews so we are unable to make this data publicly available. Some material may be made available by the authors upon request from interested researchers. Requests to access the datasets should be directed to taimetzger@g.ucla.edu.

Ethics statement

This study was reviewed by the UCLA Human Research Protection Program (OHRPP) and was determined to meet the criteria for exemption from full IRB review on December 15, 2022 (IRB#22–000893). The studies were conducted in accordance with the local legislation and institutional requirements. The Ethics Committee/Institutional Review Board waived the requirement of written informed consent for participation from the participants or the participants' legal guardians/next of kin because there was no risk of harm to participants (just a survey and interview were utilized using the internet) so oral consent could be obtained instead of written informed consent.

Author contributions

TM: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. NN: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. HL: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing. DH: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing. KN: Conceptualization, Investigation, Methodology, Visualization, Writing – original draft, Writing – review & editing. SL: Conceptualization, Investigation, Methodology, Writing – original draft, Writing – review & editing. TN: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing. QN: Investigation, Methodology, Writing – original draft, Writing – review & editing, Conceptualization. LT: Conceptualization, Investigation, Methodology, Writing – original draft, Writing – review & editing. NT: Conceptualization, Investigation, Methodology, Writing – original draft, Writing – review & editing. CL: Conceptualization, Investigation, Methodology, Writing – original draft, Writing – review & editing. RD: Conceptualization, Data curation, Formal analysis, Funding acquisition, Methodology, Project administration, Resources, Supervision, Validation, Writing – original draft, Writing – review & editing.

Funding

The author(s) declare that financial support was received for the research, authorship, and/or publication of this article. This work was provided by the Vietnamese Community Health Project at UCLA.

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

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frontiers | Frontiers in Public Health

TYPE Original Research
PUBLISHED 12 June 2024
DOI 10.3389/fpubh.2024.1416880

OPEN ACCESS

EDITED BY
Gabriele Nibbio,
University of Brescia, Italy

REVIEWED BY
Iwona Bodys-Cupak,
Jagiellonian University Medical College, Poland
Giulia Cossu,
University of Cagliari, Italy

*CORRESPONDENCE
Yingchun Xia
✉ xiayingchun@csu.edu.cn

†These authors share first authorship

RECEIVED 13 April 2024
ACCEPTED 29 May 2024
PUBLISHED 12 June 2024

CITATION
He S, Xiao T and Xia Y (2024) Life changes, self-prevention, knowledge and mental health among inflammatory bowel disease patients during COVID-19 pandemic: a cross-sectional study.
Front. Public Health 12:1416880.
doi: 10.3389/fpubh.2024.1416880

Life changes, self-prevention, knowledge and mental health among inflammatory bowel disease patients during COVID-19 pandemic: a cross-sectional study

Shiwen He†, Tao Xiao† and Yingchun Xia*

Nursing Department, The Third Xiangya Hospital, Central South University, Changsha, China

Background: With the COVID-19 pandemic going to be COVID-19 endemic, the negative impact of COVID-19 on the mental health of IBD patients cannot be ignored. This study aimed to investigate the occurrence of anxiety and depression in IBD patients during the COVID-19 pandemic and analyze the factors associated with mental health.

Methods: Patients registered at the IBD center were enrolled. Electronic questionnaires about the IBD patient's demographic information, basic knowledge of COVID-19, public self-prevention measures, daily life changes, and anxiety and depression were distributed.

Results: Two hundred and fifteen IBD patients finished this study and reported to have anxiety (27%) or depression (34%). During the COVID-19 pandemic, 10.2% of IBD patients reported their diet changes, 58.5% of IBD patients changed their daily physical activities from 3.27 ± 3.252 h to 2.30 ± 2.78 h, 33.7% of IBD patients changed their sleeping duration from 7.99 ± 1.322 h to 8.18 ± 1.447 h. IBD patients' waiting time for admission (OR: 3.688, 95%CI: 1.003–13.554), regularly oral medicine administration (OR: 18.407, 95%CI: 1.975–171.530) and diet changes (OR: 6.167, 95%CI: 2.158–17.626) were positively correlated with anxiety or depression. IBD patients' timely periodic infusion of biological agents (OR: 0.586, 95%CI: 0.413–0.830) was negatively correlated with anxiety or depression. IBD patients' knowledge of COVID-19, public self-prevention, physical activities, and sleep duration changes showed no significant correlation with anxiety and depression, all p values > 0.05.

Conclusion: The main factors of IBD patients' mental health were diet changes, waiting time for admission, taking oral medicine regularly, and timely periodic infusions of biological agents. Ensuring the supply of routine treatment and medication for IBD patients and establishing systemic online IBD self-management programs would be the focus of major public health events.

KEYWORDS

COVID-19, anxiety and depression, life changes, self-prevention, inflammatory bowel disease

Introduction

World Health Organization (WHO) declared the Corona Virus Disease 2019 (COVID-19) pandemic on 11 March 2020 and declared COVID-19 over as a global health emergency on 5 May 2023. Because of high levels of reinfection in the Omicron, reinfection events would dominate future COVID-19 dynamics (1). Susceptible populations still need to focus on preventing Omicron, such as SARS-CoV-2.

Compared with the general population, the pooled incidence of COVID-19 in inflammatory bowel disease (IBD) patients was 18% higher than that of the general population (2). IBD consists of ulcerative colitis (UC) and Crohn's disease (CD), which affect individuals from the entire age spectrum and have a substantial negative impact on quality of life (3). IBD has become a global disease with an accelerating incidence in newly industrialized countries in Africa, Asia, and South America (4). Immunosuppressant therapy, one of the main treatments for IBD patients, could significantly reduce the risk of hospital admission and surgery (5). IBD patients showed no significantly increased risk or aggravated outcomes during the COVID-19 pandemic (6). However, IBD patients treated with thiopurines, methotrexate, anti-tumor necrosis factor α agents, and corticosteroids had a higher incidence of SARS-CoV-2 infection after vaccination compared with healthy control subjects (7). Thus, stopping immunosuppressive treatments for all patients with IBD is challenging (5).

Before the COVID-19 pandemic, IBD patients had a prevalence rate of 32.1% for anxiety and 25.2% for depression, which were higher than those in the general population (8). For active IBD patients, the prevalence rate of anxiety and depression was up to 58 and 50% (9). During the COVID-19 pandemic, IBD patients had moderate to severe depression, anxiety, and stress with prevalence rates of 34.9, 32.0, and 29.7%, respectively (10). And 60.5% of IBD patients had at least moderate depression, anxiety, or stress (10). With the COVID-19 pandemic going to be COVID-19 endemic, the negative impact of COVID-19 on the mental health of IBD patients cannot be ignored.

Life changes during the COVID-19 pandemic were related to poor mental health in university students, such as giving up a daily routine, neglecting meals, tidiness, and hygiene (11). More than 50% of IBD patients did not change their IBD medication and interrupt IBD services, but they still reported a negative impact of COVID-19 on their quality of life (12). The health-related quality of life pre-COVID-19 decreased during the COVID-19 outbreak, and a lower health-related quality of life was associated with perceived stress in IBD patients (13). Social dysfunction caused by the lockdown was significantly related to COVID-19 anxiety (14). "staying at home," "canceled events" and "increased workload" were the top three life changes during the COVID-19 pandemic for IBD patients with psychological distress (15).

Even though the above studies had reported some life changes and psychological stress experienced by IBD patients, the correlation between life changes, such as diet, physical activities, sleep changes, and mental health in IBD patients were less reported. Moreover, high levels of risk perceptions of contracting COVID-19 may increase an individual's pandemic-related stress and contribute to negative mental health consequences (16). Thus, this study aimed to assess the knowledge of COVID-19, public self-prevention measures, daily life changes, and mental health in IBD patients.

Abbreviations: IBD, Inflammatory bowel disease; COVID-19, Coronavirus disease 2019.

Materials and methods

Participants and procedure

We conducted a cross-sectional survey at the Third Xiangya Hospital of Central South University, one of the midland diagnosis and treatment centers for IBD in China, between August 18, 2022, and October 18, 2022. All IBD patients registered in this center were recruited if they had no history of mental illness, were literate enough to read and write, and had and used a smartphone. IBD patients were excluded from this study if they: (1) had communication disorder or cognitive disorders, (2) had serious physical illness unable to complete the investigation, or (3) did not provide a consent form.

During the study period, the Chinese government published the ninth version of the COVID-19 prevention and control plan, which divided risk areas into high, medium, and low-risk based on the results of dynamic epidemiological investigation. People in areas with high or medium risk were encouraged to stay at home. People in low-risk areas must show the negative results of COVID-19 nucleic acid tests within 48 h when entering shopping malls, schools, and hospitals. Once the COVID-19 nucleic acid test was positive, the China Disease Prevention and Control Information System would report the activity trajectory within 2 h. The infected people would go to designated medical institutions or shelter hospitals for treatment (17).

This study was carried out through an online investigation. The study members explained the content and purpose of this study through phone calls or e-mails and invited IBD patients to finish the anonymous questionnaires. When IBD patients or guardians (patients <18 years old) agreed, study members sent the electronic questionnaires affiliated with the consent link to the patient's mobile phone within 10 min, and the link was valid for 60 days. To reduce the dropout rate, we invited IBD patients to participate in this study when admitted during the investigation. We obtained ethics approval from the Third Xiangya Hospital of Central South University Ethics Board (快I22175).

Sample size estimation

According to previous data (10), it is found that 60.5% of IBD patients had at least one mental health problem during COVID-19 pandemic. We required that with 95% confidence, the results need to fall within 15% of the overall truth rate. According to the calculation formula $N = Z^2_{1-\alpha/2}(1-p)/\varepsilon^2\gamma$, it is calculated that $N = 112$. Considering the 10% of attrition rate and the design efficiency, the questionnaires required for this cross-sectional study were at least 135 in total.

Instruments

Two questionnaires were used in this study, one is a self-made questionnaire consisting of demographic information, life changes (nine questions), knowledge of COVID-19 (15 questions), and public

self-protection measures (three questions), another is Hospital Anxiety and Depression Scale.

Demographic information

Demographic information such as age, weight, gender, time of diagnosis, comorbidity, living area, educational background, marital status, monthly income, sources of getting COVID-19 knowledge, oral medicine administration, infusions of biological agents, and waiting time for admission were collected.

Life changes

Participants reported if they had changed the frequency of food consumption, physical activity duration, sleeping duration, and medical treatment activities. Food consumption included the food categories in The Chinese Food Frequency Questionnaire: staple food (including rice, wheat flour, and other cereals), fresh vegetables, fresh fruit, meat (including pork, poultry, and fish), eggs/milk, and others (18). The definition of physical activities includes vigorous physical activities (such as heaving lifting, digging, aerobics, or fast bicycling), moderate physical activities (such as carrying light loads, bicycling at a regular pace, or doubles tennis), and walking (including walking at work, walking at home, walking to travel from place to place, and other walking) (19).

Participants reported food consumption changes by filling out the single-choice questions. "Whether your diet changed or not after the COVID-19 pandemic outbreak? (yes/no)," "If your diet changed, what kind of change in consumption of staple food, fresh vegetables/fruit, meat/eggs/milk, and others? (increased/ decreased)."

Sleep and physical activity changes were assessed by questions "How many hours of sleep did you get every night before the COVID-19 pandemic?," "How many hours of sleep do you get every night during the COVID-19 pandemic?," "How many hours did you spend on daily physical activities before the COVID-19 pandemic?," and "How many hours do you spend on daily physical activities during the COVID-19 pandemic?"

Participants reported their medical treatment activities by answering the questions. Do you take your medication regularly during the COVID-19 pandemic (yes/no)? Do you get the infusion of biological agents on time during the COVID-19 pandemic (yes/no/no need)? How long do you wait for admission (day)?

Knowledge of COVID-19 and public self-protection measures

Self-made questionnaires were used to evaluate the patients' knowledge of COVID-19 and their daily self-protection measures. The questionnaire about COVID-19 knowledge included 15 single-choice questions, 5 points for each question, with a total score of 75 points. The question" What are your major sources of COVID-19 knowledge?" was provided for participants. The questionnaire about public self-prevention measures consisted of three questions: "How many times a day have you monitored your temperature in the last 3 months?"; "How many times a week have you been out in the last 3 months?"; and "How many times a month have you been to the hospital in the last 3 months?"

Hospital anxiety and depression scale

The Hospital Anxiety and Depression Scale was used to measure symptoms of anxiety and depression and consists of two scales and 14 items, with seven items for the anxiety scale (HADS-A) and seven items for the depression scale (HADS-D). Each item score ranges from 0 to 3, and each scale (HADS-A or HADS-D) values between 0 and 21. Three ranges for both of the scales: 0–7 (non-cases), 8–10 (doubtful cases), and 11–21 (cases). When a patient has scores ≥ 8, it indicates that the patient has symptoms of depression and anxiety, and intervention treatment is needed as soon as possible (20). The Chinese version of the HADS showed good reliability and sensitivity for correctly identifying psychiatric mood disorders (21).

Statistical analysis

Data were analyzed by using SPSS 19.0 software. Frequencies and rates were used to describe the prevalence of anxiety or depression, patients' demographic information, sources of getting COVID-19 knowledge, cognition of each COVID-19 topic, public self-prevention, and life changes. Mean ± SD was used to describe the scores in COVID-19 knowledge, HADS-A, and HADS-D. Mann–Whitney U was used to analyze the HADS scores among participants with different genders, chronic diseases, living areas, marital status, diets, physical activities, sleep duration, and oral medicine regularly, and compare the knowledge of COVID-19 between participants who had anxiety or depression. Kruskall-Wallis H was used to compare the HADS-A and HADS-D scores among participants with different diagnosis times, educational backgrounds, monthly income, public self-prevention, periodic infusion of biological agents, and waiting time for admission. The impact of demographic backgrounds, COVID-19 knowledge, public health prevention, and life changes on anxiety or depression were estimated using binary logistic regression. A value of $p < 0.05$ was considered statistically significant.

Results

Participant characteristics

During August and October 2022, we enrolled 270 patients with IBD. No patients were infected with COVID-19. Fifty-six IBD patients were diagnosed with mental illness before this investigation, and 18 IBD patients refused participation. Finally, 252 IBD patients participated in this study, and 215 questionnaires were analyzed after excluding 37 invalid questionnaires. The questionnaire response rate was 79.6%, detailed in Figure 1.

The IBD patients were 32.20 ± 11.96 years old and weighed 56.02 ± 9.74 kilograms. More than 50% of them were male, diagnosed with IBD more than 1 year, with no chronic disease, living in urban areas, married, and with less than 5,000 monthly incoming, detailed in Table 1.

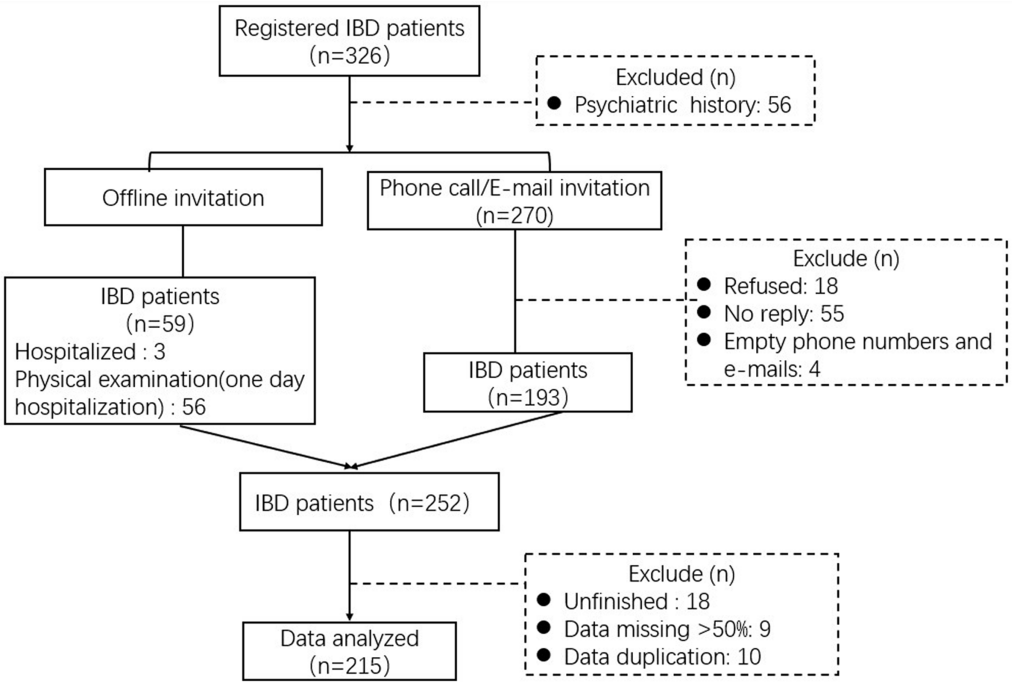

FIGURE 1
The progress of participants recruited.

TABLE 1 The demographic information and scores of HADS in IBD patients.

Characters		*n*	%	HADS-A		*p* values	HADS-D		*p* values
Gender	Male	158	73.5	5.46 ± 2.98	$Z = -0.022$	$p = 0.982$	6.02 ± 3.52	Z = −0.675	$p = 0.5$
	Female	57	26.5	5.30 ± 2.97			5.61 ± 3.17		
Diagnosis time	<1 year	75	34.9	5.23 ± 3.19	$H = 0.613$	$p = 0.736$	5.97 ± 3.67	$H = 1.227$	$p = 0.542$
	1–3 years	65	30.2	5.54 ± 3.18			6.17 ± 3.57		
	>3 years	75	34.9	5.51 ± 2.57			5.63 ± 3.06		
Complications of other diseases	Yes	38	17.7	6.11 ± 2.59	$Z = -1.169$	$p = 0.243$	6.68 ± 2.83	$Z = -1.443$	$p = 0.149$
	No	177	82.3	5.27 ± 3.04			5.75 ± 3.53		
Living areas	Urban	135	62.8	4.73 ± 3.14	$Z = -3.952$	**p < 0.001**	5.21 ± 3.38	$Z = -4.008$	**p < 0.001**
	Rural	80	37.2	6.58 ± 2.32			7.10 ± 3.20		
Education background	<High school	53	24.7	6.04 ± 2.93	$H = 7.467$	**p = 0.024**	7.40 ± 2.81	$H = 18.718$	**p < 0.001**
	High school	34	15.8	4.47 ± 2.59			4.29 ± 3.26		
	>High school	128	59.5	5.41 ± 3.04			5.73 ± 3.49		
Marital status	Unmarried	86	44.7	5.31 ± 3.07	$Z = -0.012$	$p = 0.990$	5.80 ± 3.58	$Z = -0.183$	$p = 0.855$
	Married	119	55.3	5.46 ± 2.85			5.88 ± 3.39		
Monthly income (RMB)	>5,000	41	19.1	3.98 ± 3.12	$H = 14.106$	**p = 0.001**	4.10 ± 3.41	$H = 15.079$	**p = 0.001**
	3,000–5,000	100	46.5	6.13 ± 2.71			6.68 ± 3.02		
	<3,000	74	34.4	5.26 ± 2.94			5.88 ± 3.60		

IBD, Inflammatory Bowel Disease. Significant of bold *p* values.
HADS-A, The Hospital Anxiety and Depression Scale-Anxiety.
HADS-D, The Hospital Anxiety and Depression Scale-Depression.

The prevalence of anxiety and depression

Among the IBD patients, 27% of participants had depression (HADS-A scores ≥ 8), and 34% of participants had anxiety (HADS-D scores ≥ 8). As reported in Table 1, IBD patients who lived in rural areas, had an education background below high school and had a monthly income of less than 5,000 RMB showed higher scores for anxiety and depression.

Life changes and correlation with mental health

10.2% of IBD patients reported their diet changes: staple food consumption increasing ($n = 6$, 2.8%), staple food consumption decreasing ($n = 6$, 2.8%), fresh vegetables and fruit consumption increasing ($n = 10$, 4.6%), fresh vegetables and fruit consumption decreasing ($n = 2$, 0.9%), meat/eggs/milk consumption increasing ($n = 4$, 1.8%), meat/eggs/milk consumption decreasing ($n = 8$, 3.7%), and others ($n = 6$, 2.8%).

58.5% of IBD patients changed their daily physical activities from 3.27 ± 3.252 h to 2.30 ± 2.78 h. And 33.7% of IBD patients changed their sleeping duration from 7.99 ± 1.322 h to 8.18 ± 1.447 h. 20.5 and 19.4% of IBD patients could not take oral medicine regularly or receive biological agents' infusion on time. Their life changes and correlation with mental health were shown in Table 2.

Source of COVID-19 knowledge

32.56% of IBD patients received information from hospitals. Internet/social apps and TV/broadcasts accounted for 92.56 and 83.26% of the sources of COVID-19 knowledge, respectively (details were shown in Figure 2).

The knowledge of COVID-19 and its correlation with mental health

As reported in Table 3, most questions got over 60% of the correct rate. All participants knew which kind of mask to choose during coronavirus. 11.2% of participants knew which groups were more susceptible to COVID-19 infection. There was no significant difference in COVID-19 knowledge between patients with depression/anxiety scores ≥ 8 and scores < 8. Details were shown in Table 4.

Public self-prevention and correlation with mental health

Table 5 reported that during the COVID-19 pandemic, 72.1% of the IBD patients monitored their temperature at least once a day, 37.2% of the IBD patients went out at least once a week, and 53.8% of the IBD patients did not go to the hospital as much as possible per month. With increasing frequencies of monitoring temperature, hanging out, and going to the hospital, IBD patients reported higher scores for anxiety and depression, the effects were not significant (all p values > 0.05).

Multinomial logistic regression: demographic information, knowledge of COVID-19, public self-prevention, and life changes in anxiety or depression (scores ≥ 8)

The binary logistic regression reported that the omnibus tests of model coefficients was $\chi^2 = 77.142$, p values < 0.001, and $R^2 = 0.466$. As shown in Table 6, IBD patients' waiting time for admission, taking oral medicine regularly, and diet changes were positively correlated with anxiety or depression (all p values < 0.05). Timely periodic infusion of biological agents was negatively correlated with anxiety or depression (p value < 0.05).

Discussion

During the COVID-19 pandemic, fear of infection and the necessity of social distancing have affected people's mental health (22). IBD patients are at high risk of infections and infectious complications because of malnutrition and immune-based therapies (23). We conducted a cross-sectional survey on the COVID-19 knowledge,

TABLE 2 The correlations between life changes and mental health.

Life changes		*n*	%	HADS-A		*p* values	HADS-D		*p* values
Diet	Yes	22	10.2	7.27 ± 1.91	$Z = -3.182$	**p = 0.001**	7.09 ± 4.13	$Z = -1.942$	$p = 0.136$
	No	193	89.8	5.21 ± 3.00			5.78 ± 3.33		
Physical activities	Yes	121	58.5	5.62 ± 2.91	$Z = -1.002$	$p = 0.316$	6.24 ± 3.26	$Z = -1.330$	$p = 0.184$
	No	86	41.5	5.14 ± 3.15			5.49 ± 3.60		
Sleep duration	Yes	67	33.7	5.91 ± 2.95	$Z = -1.967$	**p = 0.049**	6.10 ± 3.92	$Z = -0.304$	$p = 0.761$
	No	132	66.3	5.08 ± 3.08			5.95 ± 3.22		
Medicine regularly	Yes	171	79.5	5.30 ± 3.01	$Z = -1.069$	$p = 0.285$	5.95 ± 3.45	$Z = -0.473$	$p = 0.636$
	No	44	20.5	5.89 ± 2.80			5.77 ± 3.38		
Periodic infusion of biological agents	On time	72	39.1	4.33 ± 3.51	$H = 10.232$	**p = 0.006**	4.67 ± 3.37	$H = 21.307$	**p < 0.001**
	Not on time	42	22.8	6.19 ± 2.96			7.86 ± 3.51		
	No need	70	38.1	5.60 ± 2.54			5.86 ± 3.21		
Waiting time for admission (day)	≤3 days	149	81.0	4.98 ± 3.07	$H = 5.708$	$p = 0.058$	5.50 ± 3.44	$H = 7.879$	**p = 0.019**
	4–6 days	21	11.4	6.19 ± 3.28			7.57 ± 3.89		
	≥7 days	14	7.6	6.57 ± 2.98			7.00 ± 3.28		

HADS-A, The Hospital Anxiety and Depression Scale-Anxiety. Significant of bold p values.
HADS-D, The Hospital Anxiety and Depression Scale-Depression.

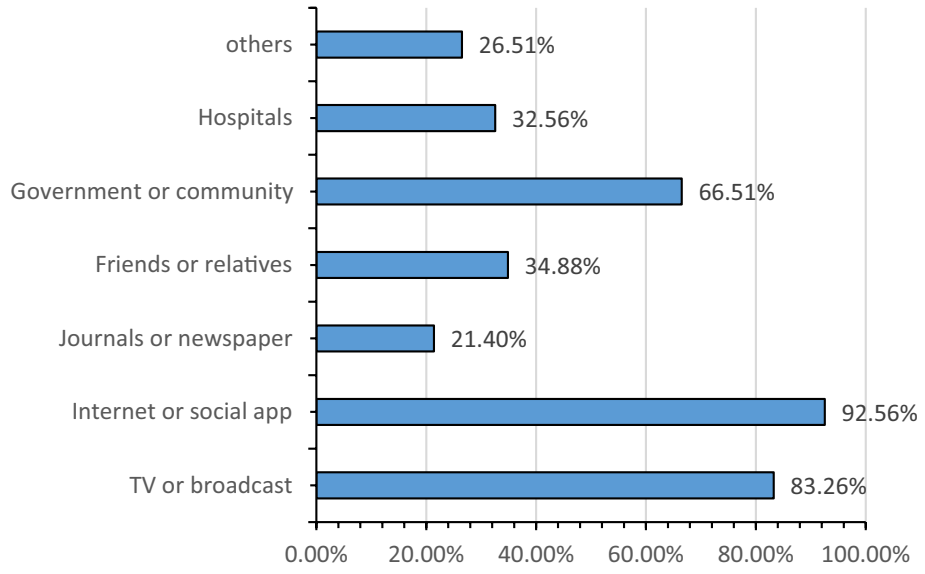

FIGURE 2
The sources of getting COVID-19 knowledge.

TABLE 3 The knowledge of coronavirus in IBD patients.

Knowledge of coronavirus	Right rate	
	N	%
1. Which one is not an effective disinfectant for coronavirus?	71	33.0
2. Which one is the possible way of spreading Coronavirus?	129	60.0
3. The range of droplet propagation is?	133	61.9
4. The most important clinical manifestations of coronavirus are?	158	73.5
5. What is the medical observation period after encountering close contact with COVID-19 infection?	205	95.3
6. What groups of people are susceptible to COVID-19 infection?	24	11.2
7. Which one belongs to public measures to prevent coronavirus infection?	175	81.4
8. How should you deal with visible dirt on your hands?	4	1.9
9. In which situations should you wash your hands?	205	95.3
10. In which situation should you wear a mask?	205	95.3
11. What kind of mask should be selected during coronavirus?	215	100
12. Caution when using masks?	184	85.6
13. How often do masks need to be replaced?	156	72.6
14. How to check the air tightness of the mask?	177	82.3
15. How many times should windows be opened for ventilation per day?	68	31.6

IBD, Inflammatory Bowel Disease.
COVID-19, Corona Virus Disease 2019.

public self-prevention measures, daily life changes, and mental health of IBD patients during the pandemic period. Consistent with previous study (23), poor mental health and a lack of management guidance for IBD under the impact of the COVID-19 pandemic were reported.

In detail, this study reported that Chinese IBD patients experienced a certain degree of anxiety and depression during the COVID-19 pandemic. This result was similar to that of Australian IBD patients (depression, 34.9%; anxiety, 32%) (10) and was consistent with the pooled incidence rate of anxiety (32.1%) and depression (25.2%) in worldwide IBD patients reported in 2021 (8). In addition, IBD patients in this study showed a higher incidence rate of anxiety and depression during the COVID-19 pandemic than before the COVID-19 pandemic (depression, 15%; anxiety, 20%) (24). The need for social distancing made face-to-face psychological counseling more difficult during the COVID-19 pandemic. And the limited access to medications and clinical specialist visits heightened IBD patients' fears of infection (3). Thus, IBD patients' mental health should be a focus.

IBD patients who lived in rural areas, with educational background lower than high school, and with a monthly income of less than 5,000 RMB showed a higher risk of getting depression or

10.3389/fpubh.2024.1416880

anxiety. However, these factors were not statistically significantly correlated with anxiety or depression. Rural areas had limited medical resources, a relatively weak ability of public health prevention measures, and a shortage of living materials (25). Lower income, high risks of contracting COVID-19, and social isolation were common risk factors for anxiety and depression (26). Most Chinese registered IBD centers are in cities, so it is hard for rural IBD patients to obtain medicine because of the longer distance. Besides, the chance of infection increases during long-distance travel to the hospital. Highly educated people had a better understanding of COVID-19 and were more active in obtaining information about COVID-19; therefore, they were more confident in facing the COVID-19 pandemic (27).

For IBD patients, dietary changes have been incorporated into therapeutic strategies (28). This study reported that a few IBD patients changed their diet, and diet changes showed as a risk factor for anxiety or depression. It implied that IBD patients seemed to have realized the importance of diet and strived to reduce their dietary changes. During the COVID-19 pandemic, general people got higher BMI and showed more snacks, sugary foods, and alcoholic beverages, less fruit and vegetable consumption (29). IBD patients showed less healthy diet changes (30, 31): fewer food choices and a higher risk of precipitous weight loss. Food supply decreased because of people hoarding food and the termination of production (32). This study showed that several participants increased or decreased the consumption of staple food, fresh vegetables, fruit, and meat/eggs/milk. Because of the limited number of participants, it is difficult to analyze which changes in diet are related to their anxiety or depression. More studies were needed to determine whether psychological factors affect dietary changes or whether dietary changes affect psychology. Anyway, maintaining food supply during public emergency events is crucial for IBD patients.

This study revealed that IBD patients decreased physical activity and increased sleep time during the COVID-19 pandemic. The changes in physical activity and sleeping time had no significant correlation with mental health (30, 33), and changes in physical activity did not influence the association between mental health and sleep (33). Differently, previous studies indicated that 40.5% of IBD patients reported worsened sleep during the COVID-19 pandemic (31), and sleep disturbances (such as difficulties with falling asleep, repeated wake-up, and early awakening) were statistically significantly

TABLE 4 The correlations between knowledge of COVID-19 and mental health.

IBD patients *N* (%)		Knowledge of COVID-19		
Anxiety				
Scores ≥ 8	57 (27)	49.91 ± 5.862	$Z = -0.772$	$p = 0.440$
Scores < 8	158 (73)	48.73 ± 9.255		
Depression				
Scores ≥ 8	73 (34)	47.33 ± 8.083	$Z = -1.823$	$p = 0.068$
Scores < 8	142 (66)	49.93 ± 8.588		

TABLE 5 The correlations between public self-prevention and mental health.

Questions		*n*	%	HADS-A		HADS-D	
Monitoring temperature (times/day)	0	60	27.9	5.35 ± 3.18	$H = 8.983$	5.87 ± 3.09	$H = 2.590$
	1–2	136	63.3	5.21 ± 2.82	**p = 0.011**	5.78 ± 3.54	$p = 0.274$
	3 and more	19	8.8	7.16 ± 2.97		7.00 ± 3.62	
Hanging out (times/week)	0	80	37.2	4.86 ± 3.11	$H = 3.670$	5.75 ± 3.86	$H = 0.308$
	1–2	87	40.5	5.68 ± 2.90	$p = 0.160$	5.94 ± 3.13	$p = 0.857$
	3 and more	48	22.3	5.88 ± 2.79		6.13 ± 3.24	
Going to hospital (times/month)	0	105	53.8	5.58 ± 2.78	$H = 2.388$	5.90 ± 3.59	$H = 3.557$
	1–2	80	41.1	4.88 ± 3.29	$p = 0.303$	5.75 ± 3.40	$p = 0.169$
	3 and more	10	5.1	5.40 ± 3.50		8.00 ± 2.11	

HADS-A, The Hospital Anxiety and Depression Scale-Anxiety. Significant of bold *p* values.
HADS-D, The Hospital Anxiety and Depression Scale-Depression.

TABLE 6 Multinomial logistic regression: demographic information, knowledge of COVID-19, public self-prevention, and life changes in anxiety or depression (scores ≥ 8).

Characters	*B*	OR	95% C.I.		*p* values
Living areas	0.321	1.378	0.954	1.990	0.087
Monitoring temperature (times/day)	0.580	1.787	0.934	3.419	0.080
Waiting time for admission (day)	1.305	3.688	1.003	13.554	**0.049**
Periodic infusion of biological agents	−0.535	0.586	0.413	0.830	**0.003**
Oral medicine administration regularly	2.913	18.407	1.975	171.530	**0.011**
Knowledge of COVID-19	−0.035	0.965	0.924	1.008	0.110
Diet changes	1.819	6.167	2.158	17.626	**0.001**
Constant	−2.973	0.051			0.072

COVID-19, Corona Virus Disease 2019. Significant of bold *p* values.

associated with anxiety and depression (33). IBD patients who had anxiety and depression also were more likely to have worse daily functioning and lower physical activity (29, 31). Therefore, more studies are needed to focus on what kind of physical activity and sleep changes in IBD patients and how these changes affect their mental health.

This study indicated that more than 50% of IBD patients could take oral medicine regularly and receive timely periodic infusions of biological agents. Consistently, El-Dallal and colleagues found that less than 20% of IBD patients reported changing their biologic medication infusion schedules and medication regimens, respectively (31). Harris et al. (12) found that 87% of IBD patients did not change their IBD medication, and most of their services were largely uninterrupted. The situation was different in Italy: 94.5% of IBD patients had stopped or delayed biological treatment, and 5.5% had continued their therapy regularly (34). These differences may be related to the severity of the epidemic and quarantine policies in different countries. Moreover, this study showed that going to the hospital for periodic infusion of biological agents was a protective factor of depression or anxiety. Taking medicine regularly was not a significant factor for anxiety or depression in univariate analysis, but after controlling for other lifestyle factors, taking medication regularly was an independent risk factor for depression or anxiety. The reason may be that other factors in life change interacted with taking medication regularly. Unlike biologic agents which were infused on a monthly cycle, oral medicine was administrated daily. Daily medication needs caused higher pressure for IBD patients in the quarantine environments during the COVID-19 pandemic. According to Mohammad and colleagues' study (35), patients showed higher adherence to health protocols than healthy people. Medicine and biological infusion are always emphasized in IBD therapies by doctors. Thus, ensuring the supply of routine treatment and medication for IBD patients would be good for alleviating their depression and anxiety.

This study showed that IBD patients had good motivation for knowing about COVID-19 and showed good implementation of public self-prevention measures. 53% of the IBD patients had received COVID-19-specific health education, and most of them thought that the provided knowledge was useful (10). However, most IBD patients got COVID-19 information from the internet/social app, TV, broadcast, government, and community, while not from the hospital in this study. IBD patients were still worried about the COVID-19 pandemic (56.0%), and the potential adverse effects of continuing immunosuppressants (36). 43.6% of IBD patients felt more vulnerable to COVID-19 infection due to their condition (43.6%) (37). This study reported that less than 30% of the IBD patients knew what kind of people are susceptible to COVID-19 and did not know how to deal with visible dirt on their hands, even though good hand hygiene is crucial to protect vulnerable patients (12). Although 90% of IBD patients received "at-risk" notifications from multiple sources, all IBD patients requested frequent updates of COVID-19 information from their gastroenterologists (12, 36). Therefore, the IBD patients lacked hospital support, especially for IBD self-management guidance in COVID-19.

Under the guidance of hospital gastroenterologists, general measures recommended for COVID-19 should focus on the specific needs of IBD patients. IBD patients preferred telemedicine to hospital visits and used telemedicine to address their concerns regarding COVID-19 infection and IBD (36). Establishing systemic online IBD self-management programs guided by hospitals has been encouraged, such as online guidance with hospital multidisciplinary cooperation and the supervision of patients' skills through specific questionnaires (38). Telemedicine has been recommended during the COVID-19 pandemic and has been proven to reduce time to remission, outpatient visits, and hospital admissions (37, 39). It could also reduce the economic burden and infection risk for people living in remote rural areas and with poor economic. A previous study (40) indicated that the content of self-management programs should include medicine administration, proactively reducing transmission, managing hospital and healthcare facility exposure, infusion access, nutrition, reducing disease activity, smoking cessation, and vaccination. As the pandemic continues, the self-management of depression and anxiety should also be added to IBD self-management programs. Regardless, building a targeted self-management system for IBD patients during the COVID-19 pandemic is supported.

Limitations

There were some limitations in this study. At first, this was a cross-sectional study, and the results cannot predict the development of mental health in IBD patients. Future prospective cohort studies are indispensable. Secondly, the reliance on self-reports may be prone to misinterpretation, and the remote electronic questionnaire made it hard for us to observe the filling process. Then, during the COVID-19 pandemic, IBD patients were often isolated at home, and whether their psychological status was closely related to the changes in their family support was not investigated in this study. At last, the participants in this study were from one hospital in central China, and the data on diet changes was small and limited the results of diet changes on mental health, so there is a need to expand the sample sources to different regions.

Conclusion

To our knowledge, our study is the first cross-sectional study to assess the mental health outcomes, COVID-19 knowledge, public self-prevention measures, and life changes in Chinese IBD patients during the COVID-19 pandemic. We revealed that IBD patients knew about COVID-19 and showed good implementation of public self-prevention measures, but they lacked systemic targeted self-management and support from hospitals. We found that IBD patients' diet changes, waiting time for admission, taking oral medicine regularly, and timely periodic infusions of biological agents were related to depression and anxiety.

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 humans were approved by Third Xiangya Hospital of Central South University Ethics Board. The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation in this study was provided by the participants' legal guardians/next of kin.

Author contributions

SH: Writing – review & editing, Writing – original draft. TX: Writing – original draft, Methodology, Investigation, Data curation. YX: Writing – original draft, Supervision, Software, Resources.

Funding

The author(s) declare that no financial support was received for the research, authorship, and/or publication of this article.

Acknowledgments

We appreciate all the IBD participants for participating in this study. We appreciate the gastroenterology medical staff from the Third Xiangya Hospital of Central South University for helping us connect with patients.

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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frontiers | Frontiers in Public Health

TYPE Original Research
PUBLISHED 08 August 2024
DOI 10.3389/fpubh.2024.1404897

OPEN ACCESS

EDITED BY
Yuka Kotozaki,
Iwate Medical University, Japan

REVIEWED BY
Ava Casados,
Children's Hospital of Orange County, United States
Najmeh Shahini,
Golestan University of Medical Sciences, Iran

*CORRESPONDENCE
Ariane L. Rung
arung@unmc.edu

RECEIVED 21 March 2024
ACCEPTED 29 July 2024
PUBLISHED 08 August 2024

CITATION
Rung AL, Oral E, Prusisz T and Peters ES (2024) Disparities and protective factors in pandemic-related mental health outcomes: a Louisiana-based study. *Front. Public Health* 12:1404897. doi: 10.3389/fpubh.2024.1404897

Disparities and protective factors in pandemic-related mental health outcomes: a Louisiana-based study

Ariane L. Rung[1]*, Evrim Oral[2], Tyler Prusisz[3] and Edward S. Peters[1]

[1]Department of Epidemiology, College of Public Health, University of Nebraska Medical Center, Omaha, NE, United States, [2]Biostatistics and Data Science Program, School of Public Health, Louisiana State University Health Sciences Center, New Orleans, LA, United States, [3]Epidemiology and Population Health Program, School of Public Health, Louisiana State University Health Sciences Center, New Orleans, LA, United States

Introduction: The COVID-19 pandemic has had a wide-ranging impact on mental health. Diverse populations experienced the pandemic differently, highlighting pre-existing inequalities and creating new challenges in recovery. Understanding the effects across diverse populations and identifying protective factors is crucial for guiding future pandemic preparedness. The objectives of this study were to (1) describe the specific COVID-19-related impacts associated with general well-being, (2) identify protective factors associated with better mental health outcomes, and (3) assess racial disparities in pandemic impact and protective factors.

Methods: A cross-sectional survey of Louisiana residents was conducted in summer 2020, yielding a sample of 986 Black and White adults. The exposure was overall pandemic impact, measured using the Epidemic-Pandemic Impacts Inventory, and the outcome was general well-being (GWB), measured with the General Well-Being Schedule. Potential protective factors included social support, resilience, and social cohesion. Linear regression models were constructed to examine the association between pandemic impact and GWB, with each protective factor added as an effect modifier. These relationships were further assessed for differences by race.

Results: Pandemic stressors can be grouped into social, health, work, finance, and family-related impacts. Black persons displayed higher levels of pandemic impact as well as lower levels of social support, resilience, and social cohesion ($p < 0.0001$), highlighting existing racial disparities, though Black respondents and White respondents exhibited no differences in general-well being. Social support, resilience, and social cohesion were identified as protective factors for both groups ($p < 0.0001$, respectively), but these protective effects deteriorated as pandemic impacts increased. The addition of a pandemic impact by race interaction term was also significant in each model ($p = 0.0020$, $p < 0.0001$, and $p = 0.0095$, respectively) and showed that the protective effects of social support and resilience deteriorated more rapidly for Black persons than White persons, while the protective effects of social cohesion deteriorated more rapidly for White persons than Black persons.

Discussion: This study emphasizes the importance of psychosocial resources in buffering the mental health impact of pandemics. It also suggests greater vulnerability for marginalized communities lacking access to crucial support

systems. Findings underscore the need for targeted interventions that bolster access to social support, promote resilience, and strengthen social cohesion, particularly within minority groups. Additionally, policymakers should consider proactive measures to assist in recovery and mitigate the disproportionate impact of future crises on vulnerable populations.

KEYWORDS

mental health, COVID-19, social support, resilience, social capital, social cohesion, race

1 Introduction

Beginning in March 2020, the COVID-19 pandemic caused major disruptions to society, including over 100 million confirmed cases and over 1 million deaths across the United States alone (1). Mitigation measures such as lockdowns, isolation and quarantine, physical distancing requirements, school closures, and restrictions on gatherings have all impacted citizens' lives in unprecedented ways. Given the likelihood of future pandemics that may require similar mitigation measures (2), an understanding of their impact on mental health is critical. Research has detailed a range of mental health effects triggered by the pandemic. For example, a review of 68 studies found a significantly higher prevalence of depression, anxiety, insomnia, PTSD, and psychological distress in pandemic-affected countries around the world compared to rates usually observed in the general population (3). An October 2021 poll found that half of all US households reported a member experiencing serious problems with depression, anxiety, stress, or sleeping in the previous few months (4).

The psychological sequelae from the COVID-19 pandemic likely stem from a variety of stressors, including fear of becoming infected with and dying from COVID-19, loneliness and social isolation due to sheltering in place and other containment measures, financial hardship, and loss of employment, to name just a few (5–7). In 2021, 38% of households across the US reported facing serious financial problems in the previous months, 20% reported experiencing serious problems with getting childcare, and 24% reported having a worse job situation now compared to before the outbreak (4).

Long-term research priorities emphasize the need to better understand the buffering effects of social relationships during stressful events (8). Given the global impact that the pandemic has had on population mental health, identifying potential mitigating factors of these stressors on mental health will be critical. Social support is one such mitigating factor, as it is known to be protective for mental health and psychological well-being (9, 10). We define social support as the perceived availability of functional support in the form of emotional, instrumental, appraisal, and informational support (11, 12). In the context of acute disasters, social support can moderate the effects of disaster-related stressors on psychological outcomes (13). When levels of social support are high, they can be protective against poor mental health outcomes. It is thus reasonable to hypothesize that social support may ameliorate the impact of COVID-19 on individuals' mental health. Indeed, direct evidence exists showing that the availability of social support was inversely correlated with anxiety level among Chinese college students during the early part of the pandemic (14).

Another potential mitigating factor is resilience, frequently defined as the ability to adapt well in the face of adversity, or to "bounce back" (15). It is often cited as a reason for why people who experience a traumatic event do not develop psychopathology (16). It has been well-studied in the disaster literature, where findings suggest that resilience characteristics can identify those who are exposed to a disruptive event but are still able to maintain a relatively healthy level of psychological functioning (16). A survey of US adults during the early pandemic found that psychological resilience was significantly lower compared to published norms, and lower scores were associated with worse mental health outcomes, such as depression, suicidal ideation, and anxiety (17). Resilience is thus another factor that could play a role in how individuals respond to the pandemic.

A third potential mitigating factor is social cohesion, which is the degree of trust, familiarity, values, and neighborhood network ties shared among residents (18). It is often construed as the foundation from which social capital arises and is distinct from social support in that it describes patterns of social interaction rather than an individual's access to a single resource (18). Scholars have suggested that localities with higher levels of social capital may be better able to respond to the COVID-19 pandemic (19, 20). The feelings of trust, norms, and networks inherent in social cohesion/social capital may be particularly relevant during a pandemic, when these characteristics could facilitate collective action (19). They may benefit members of a community through the creation of cultures of obligation or expected reciprocity, enhanced community-based information channels, or the establishment of informal codes of socially normative behaviors (21). A number of studies have demonstrated that places with more social capital have fewer COVID-19 cases and deaths. For example, one study showed that an increase from the 25th to the 75th percentile of social capital in a US county would lead to an 18% decline in the cumulative number of COVID-19 infections and a 6% decline in the number of deaths (19). Research has also demonstrated that states with higher levels of social capital and social trust tend to have higher COVID testing rates, even after controlling for party affiliation, income, income inequality, and racial diversity (22). Certain forms of social capital have even been associated with better adherence to social distancing, as measured by the percentage of mobile devices that did not leave home in a given county on a given day (23). Given the evidence that social capital may also be inversely associated with common mental disorders (24), it is possible that social capital plays a role in softening the effects of COVID-related stressors on mental health.

Race complicates efforts to disentangle the pandemic's effects on mental health. Black persons in the United States were

disproportionately affected by COVID-19 compared to other races. They had a higher COVID-19 mortality rate compared to White persons (88/100,000 vs. 40/100,000, respectively) and were twice as likely to be hospitalized and 3.6 times as likely to die from COVID-19 compared to White persons (25). These disparities appeared to be driven primarily by systemic structural disadvantages, such as greater barriers to educational attainment, lower household income, and residing in lower income neighborhoods (26), all of which predisposed them to chronic diseases, which in turn lead to development of comorbidities that put them at higher risk for COVID-19. A direct path to COVID-19 infection also existed, as evidenced by their disproportionate representation in essential or high risk jobs that prevented them from sheltering in place, as well as crowded housing that facilitated transmission, and an increased likelihood of living with health care workers (25, 27). At the same time, Black persons were experiencing collective trauma as a result of police killings of figures such as George Floyd and Breonna Taylor, resulting in independent impacts on their mental health (28, 29), and making it even more difficult to unravel the mental health effects of the pandemic.

In addition to these pandemic- and context-related impacts, Black individuals already tend to bear a greater burden from unmet mental health needs. While the prevalence of certain mental disorders among Black individuals is not generally higher compared to White individuals, they are less likely to receive diagnoses and treatment, particularly high-quality treatment, for their mental health concerns (7, 30). Moreover, psychological effects from the pandemic were more pronounced among racial and ethnic minorities, as evidenced by elevated suicide rates, suicidal ideation, grief, and related mental health symptoms for family members of those who died due to COVID-19 (27).

Potential mitigating factors such as social support, resilience, and social cohesion may operate differently for Black persons compared to White persons. While evidence suggests that racial minorities in the US received less social support from family, friends, and partners during the pandemic compared to White persons (31), the literature on racial/ethnic differences in resilience is mixed; some studies demonstrate higher levels of resilience among Black people (32), while others show a lower prevalence (33) or no difference (34). An emerging perspective on resilience in the Black community emphasizes a greater focus on the strength of Black people, who have collectively survived generations of trauma; examples of extraordinary strength of mind and body under such adverse conditions suggest that resilience may be an overlooked target of intervention in this population (35). The literature on racial/ethnic differences in individual-level social cohesion is even more sparse, although there are some indications that Black persons score lower on social cohesion scales than White persons (36). These potential differences in how mitigating factors operate underscore the need to examine the role of racial disparities in the promotion of pandemic-related psychological well-being in order to identify more targeted pandemic responses.

The objectives of this study are to (1) describe the specific COVID-19-related impacts associated with general well-being, (2) identify protective factors associated with better mental health outcomes, and (3) assess racial disparities in pandemic impact and protective factors.

2 Materials and methods

2.1 Participants and survey administration

Data were collected using a cross-sectional survey of Louisiana residents between July 23 and September 6, 2020. Surveys were administrated through Qualtrics XM, a commercial survey sampling and administration company. Participants were acquired from existing pools of research panel samples who had agreed to be contacted for research studies. Individuals received an email invitation to the survey if they were preregistered for Qualtrics Panels and had completed an online baseline proprietary survey. Panelists were then invited to participate electronically and opted in by activating a survey link directing them to the study consent webpage and survey instrument. After consenting, participants were directed to the questionnaire. The LSUHSC-New Orleans Institutional Review Board reviewed and exempted the study.

To ensure the representativeness of the survey sample, Qualtrics strived to balance participants by age, gender, and race distributions for the state of Louisiana. In order to participate, respondents had to reside in Louisiana and be over the age of 18 years. 1,050 participants completed the survey. To ensure sufficient sample sizes by race, 986 respondents who self-reported White or Black race were retained in the final analytic dataset.

2.2 Measures

2.2.1 Outcome

The outcome for this study was general well-being, which measures subjective feelings of psychological well-being and distress. The General Well-Being Schedule (GWB) is a brief, reliable, valid, and widely used self-administered questionnaire that addresses subjective well-being, using 18 items developed for the U.S. Health and Nutrition Examination Survey (37, 38). Each item incorporates the time frame "during the last month," with lower scores reflecting distress and higher scores reflecting positive well-being. The possible range of scores is 0–110. While the measure has established cut-offs, with 0–60 reflecting "severe distress," 61–72 "moderate distress," and 73–110 "positive well-being," GWB is treated as a continuous variable for this analysis.

2.2.2 Exposure of interest

The primary exposure for this study was negative pandemic-related impacts. A series of questions from the Epidemic-Pandemic Impacts Inventory (EPII) (39) was asked about respondents' experiences since the beginning of the pandemic in Louisiana in March 2020, including items such as being laid off from a job, being unable to pay bills, being unable to access medical care, or having increased conflict with a partner. Possible response options were: no one in household affected (0), one person in household affected (1), and at least 2 people in household affected (2). Responses to the questions were subjected to a principal components analysis (40). The principal axis method was used to extract the components, and this was followed by a varimax (orthogonal) rotation. Variables that did not load on any factors or that loaded on more than one component were excluded, resulting in a final selection of 23 items. Only the first five components were retained for rotation, which accounted for 54%

10.3389/fpubh.2024.1404897

TABLE 1 Rotated factor pattern and final communality estimates from principal component analysis of pandemic-related impacts ($N = 986$).

	Component										
Item	1		2		3		4		5		Communality estimate
Laid off from job	9		-1		66	*	2		34		0.56
Had to close own business	-2		15		67	*	20		2		0.52
Reduced work hours or furloughed	18		8		68	*	5		16		0.53
Had to lay-off or furlough employees or people supervised	−4		23		67	*	25		4		0.57
Hard time making the transition to working from home	7		21		49	*	37		−2		0.42
Unable to get enough food	6		21		13		16		82	*	0.76
Unable to get healthy food	8		25		6		22		78	*	0.72
Unable to pay important bills like rent or utilities	8		12		27		15		73	*	0.64
Unable to get needed medications	7		53	*	21		36		26		0.52
Childcare or babysitting unavailable when needed	9		15		28		59	*	13		0.48
More conflict with child or children	17		4		7		80	*	12		0.68
Family or friends had to move into your home	−5		19		30		61	*	14		0.52
Increase in conflict with a partner or spouse	24		11		8		54	*	18		0.40
Separated from family or close friends	64	*	17		−3		6		6		0.45
Unable to do enjoyable activities or hobbies	74	*	9		5		7		11		0.58
Unable to visit loves ones in hospital	45	*	39		17		3		11		0.40
Family celebrations canceled/restricted	79	*	5		1		8		−1		0.63
Planned travel/vacations canceled	70	*	6		12		7		−9		0.53
Increase in health probs not related to pandemic	14		64	*	6		19		22		0.52
Eating more unhealthy foods	50	*	13		2		23		25		0.38
Unable to access medical care for serious condition	−3		68	*	20		27		9		0.59
Delay getting medical care	21		72	*	7		2		5		0.57
Isolated due to existing health conditions that increase risk of infection	21		65	*	13		0		15		0.50

Values are multiplied by 100 and rounded to nearest integer. *Indicates absolute values greater than or equal to 0.4.

of the total variance. Questionnaire items and corresponding factor loadings are presented in Table 1. In interpreting the rotated factor pattern, an item was said to load on a given component if the factor loading was 0.40 or greater for that component and was less than 0.40 for the other. Scores were summed to create a single overall pandemic impact score. Higher scores are indicative of higher levels of negative pandemic-related impact.

Scores were also summed to create the five components of pandemic-related impacts for descriptive purposes. They were identified as: social impacts, health impacts, work impacts, financial impacts, and family impacts. Social impacts related to the pandemic included being unable to do enjoyable activities or having family celebrations canceled. Health impacts included isolation due to existing health conditions or delays in getting medical care. Work impacts included having reduced work hours or being laid off from a job. Finance impacts included being unable to pay bills or get enough food. Family impacts included increases in conflict with partners or children and childcare availability.

2.2.3 Effect modifiers

Three variables were hypothesized as potential buffers of the pandemic impact-general well-being relationship and treated as possible effect modifiers.

Social support, defined as the perceived availability of functional support in the form of emotional, instrumental, appraisal, and informational support, was measured using the 19-item MOS Social Support Survey (12). Scores for an overall index were calculated by averaging the scores for all items, resulting in a range of 1 to 5, with higher scores indicating more support. Scores were then dichotomized at the median into low and high support.

Resilience, a measure of successful stress-coping ability, was assessed using the Connor-Davidson Resilience Scale 10 (CD-RISC-10), which reflects the ability to bounce back from a variety of challenges that can arise in life (41). The measure consists of 10 items rated on a scale of 0 (not true at all) to 4 (true nearly all the time). Example items include "I am able to adapt when changes occur" and "I can deal with whatever comes my way." An overall score was calculated by summing the 10 items, resulting in a range of 0 to 40, with higher scores suggesting greater resilience. Scores were then dichotomized at the median into low and high resilience.

The third potential buffer was social cohesion, a component of social capital (42). Social cohesion is conceptualized as the degree of trust, familiarity, values, and neighborhood network ties shared among residents and is measured at the individual level. Five items (42) asked respondents how strongly they agreed with the following statements: "This is a close-knit neighborhood" (reverse coded),

"People around here are willing to help their neighbors" (reverse coded), "People in my neighborhood generally do not get along with each other," "People in my neighborhood do not share the same values," and "People in my neighborhood can be trusted" (reverse coded). Response options ranged from strongly agree (1) to strongly disagree (5). A score for social cohesion was calculated by averaging items, resulting in a range of 1 to 5, with higher scores reflecting more social cohesion. Scores were then dichotomized at the median into low and high cohesion.

2.2.4 Other covariates

Participants self-reported their race; only those self-reporting as White or Black/African American were retained for this analysis. Other variables included sex (male vs. female), age (18–24 years, 25–44 years, 45–64 years, and 65+ years), marital status (married or partnered vs. widowed, divorced, separated, or single), income (less than $50,000/year vs. $50, 000/year or more), and presence of children 0–17 years in household.

2.3 Analysis

Descriptive statistics were calculated for demographic variables including race, the general well-being outcome, pandemic experiences (overall score as well as subscores), and the potential buffering characteristics of social support, resilience, and social cohesion. They are presented for the whole sample and then stratified by race. *p*-values for racial differences were calculated using chi-square tests for categorical variables and t-tests for continuous variables. Simple linear regression modeling was performed to assess the unadjusted associations between each demographic characteristic, pandemic-related impact, and buffering characteristic with general well-being. Subsequently, three separate multiple linear regression models were used to assess the effects of race and buffering characteristics along with their interactions with pandemic-related impacts (overall score only) on general well-being. These models were adjusted for potential confounding variables of sex, age, marital status, income, and presence of children in household. All statistical analyses were performed using SAS 9.4 for Windows (SAS Institute Inc., Cary, North Carolina).

3 Results

Table 2 presents the participant characteristics for the total sample by race. 68% of the sample is White and 32% Black. The sample is predominantly female, 25–44 years, and evenly split between married and single. 57% of respondents had a 2019 household income of less than $50,000 per year. The mean general well-being score was 65.14 (SD 21.3). About half of respondents reported having high levels of social support, 45% reported high levels of resilience, and 44% reported high levels of social cohesion. Black respondents were more likely than White respondents to be female, younger than 44 years, single, have a household income less than $50,000 per year, and to have any children under 18 years in the household. Black persons were more likely than White persons to report having low levels of all three buffering characteristics of social support, resilience, and social cohesion.

Pandemic-related impacts are listed in Table 3 and grouped by subscore category. Overall pandemic impact scores ranged from 0 to 39, with a mean of 10.0 (SD 9.6). Within the sample, 95% scored 24 or lower on the overall scale; 75% scored under 14 or lower, 50% scored 9 or lower, and 10% of the sample scored 2 or lower. Compared to White persons, Black persons tended to experience higher levels of pandemic-related impacts, particularly in the categories of work (White persons mean 1.07, SD 1.49 vs. Black persons mean 1.78 SD 2.10, $p < 0.0001$), finance (White persons mean 0.86, SD 1.60 vs. Black persons mean 1.44 SD 1.70, $p < 0.0001$), family (White persons mean 0.82, SD 1.43 vs. Black persons mean 1.09 SD 1.67, $p = 0.0116$), and the overall pandemic impact score (White persons mean 9.61, SD 6.89 vs. Black persons mean 10.94 SD 8.33, $p = 0.0143$).

Unadjusted associations of participant characteristics with general well-being are shown in Table 4. Demographic characteristics associated with higher levels of general well-being include being male, over age 65 years, married or partnered, and having an income over $50,000/year. Those having children between the ages of 0 and 17 years in the house scored lower on the general well-being scale than their counterparts without children. The pandemic impact score was negatively related to general well-being; for every one-unit increase in the overall pandemic score, general well-being decreased by 1.19 (95% CI −1.35, −1.03). The three buffering characteristics were positively associated with general well-being. Individuals with high social support had an average general well-being score that was 15.21 points (95% CI 12.73, 17.70) higher than those with low social support. Similarly, those with high resilience had an average general well-being score 22.13 points (95% CI 19.85, 24.42) higher than those with low resilience, and those with high social cohesion were 11.84 points (95% CI 9.13, 14.56) higher than those with low social cohesion.

To examine how the potential moderating effects of social support, resilience, and social cohesion influence the relationship between general well-being and pandemic impacts, we created three models that included an interaction term for each buffering characteristic, adjusting for race, sex, age, marital status, income, and presence of children (see Table 5; Figures 1–3). Respondents with higher levels of social support and social cohesion had higher levels of general well-being, holding race constant, until they reached extreme levels of pandemic impact (e.g., > 90–95th percentile), after which these factors ceased to be protective and actually became detrimental to well-being (pandemic impact by social support interaction coefficient = −0.63, 95% CI −0.93, −0.33 and pandemic impact by social cohesion interaction coefficient = −0.73, 95% CI −1.07, −0.40). For resilience, though, we found that respondents with higher levels of resilience had high levels of general well-being, a protective effect that endured regardless of level of pandemic impact (pandemic impact by resilience interaction coefficient = −0.57, 95% CI −0.85, −0.29).

To explore how race further impacts the general well-being—pandemic impact relationship, we then included a pandemic impact by race interaction term. Table 6 shows the adjusted effects of race and each potential buffering characteristic on general well-being in three separate models. In each of the models shown in Table 6, both interaction terms were significantly associated with general well-being, so for each buffer we present models stratified by race for simplicity of interpretation, along with their corresponding interaction plots (Table 7; Figures 4–6).

Table 7 shows the effect of pandemic impact on general well-being by high versus low levels of each buffering characteristic,

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TABLE 2 Demographics of sample, Louisiana, July–September 2020, *N* = 986.

	Total		White (*n* = 673)		Black (*n* = 313)		*p*-value for race differences
	N	%	N	%	N	%	
General Well-Being (mean, SD)	65.14	21.31	65.46	22.31	64.45	18.99	0.4637
Sex							0.0027
Male	394	40.08	290	43.28	104	33.23	
Female	589	59.92	380	56.72	209	66.77	
Age							<0.0001
18–24 yrs	192	19.47	81	12.04	111	35.46	
25–44 yrs	360	36.51	240	35.66	120	38.34	
45–64 yrs	269	27.28	209	31.05	60	19.17	
65+ yrs	165	16.73	143	21.25	22	7.03	
Marital Status							<0.0001
Married/partnered	470	48.11	386	57.53	84	27.45	
Single	507	51.89	285	42.47	222	72.55	
Income, Annual HH, 2019							<0.0001
Less than $50 K/yr	558	56.59	335	49.78	223	71.25	
$50 K/yr or more	428	43.41	338	50.22	90	28.75	
Any children 0–17 years in HH							<0.0001
No	613	62.17	449	66.72	164	52.40	
Yes	373	37.83	224	33.28	149	47.60	
Social support score							<0.0001
Low	495	50.20	303	45.02	192	61.34	
High	491	49.80	370	54.98	121	38.66	
Resilience score							0.0463
Low	543	55.07	356	52.90	187	59.74	
High	443	44.93	317	47.10	126	40.26	
Social cohesion score							<0.0001
Low	487	55.98	307	50.58	180	68.44	
High	383	44.02	300	49.52	83	31.56	

Missing values were reported for gender (*n* = 3), marital status (*n* = 9), and social cohesion score (*n* = 116).

stratified by race. In the case of social support (Figure 4), for White persons, high levels of social support are protective for general well-being at almost every level of pandemic impact (pandemic impact by social support interaction coefficient = −0.49, 95% CI −0.86, −0.12). For Black persons, high levels of social support are protective for general well-being as well, but only while pandemic impact scores are below about the 95th percentile; once pandemic impact scores are in the extreme range (top 5th percentile), high levels of social support result in worse general well-being compared to low levels of social support (pandemic impact by social support interaction coefficient = −0. 55, 95% CI −1.11, −0.003). For both races, higher pandemic impact scores are associated with decreased general well-being as expected; however, having high social support further aggravates this decrease, and this phenomenon happens more quickly for Black persons than White persons.

In the case of resilience (Figure 5), for White persons, high levels of resilience are protective for general well-being at every level of pandemic impact, as indicated by the almost parallel lines and non-significant interaction term (pandemic impact by resilience interaction coefficient = −0.33, 95% CI −0.68, 0.02). For Black persons, high levels of resilience are similarly protective for general well-being but only until pandemic impact scores reach extreme levels (e.g., > 95th percentile), after which high levels of resilience result in worse general well-being compared to low levels of resilience (pandemic impact by resilience interaction coefficient = −0.75, 95% CI −1.24, −0.27).

For social cohesion (Figure 6), we see almost the opposite effects. For White persons, high levels of social cohesion are protective for general well-being until pandemic impact levels reach almost the 90th percentile (pandemic impact by social cohesion interaction coefficient = −0.86, 95% CI −1.27, −0.45). For Black persons, by contrast, high levels of social cohesion are protective for general well-being at almost all pandemic impact levels, as indicated by the non-significant interaction term (pandemic impact by social cohesion interaction coefficient = −0.33, 95% CI −0.91, 0.24).

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TABLE 3 Pandemic-related impacts ($N = 986$).

	Total ($N = 986$)		White persons ($n = 673$)		Black persons ($n = 313$)		p-value
	Mean	SD	Mean	SD	Mean	SD	
Social impacts	5.22	3.29	5.34	3.28	4.95	3.28	0.0842
Separated from family or close friends	0.80	0.81	0.84	0.82	0.71	0.76	0.0226
Unable to do enjoyable activities or hobbies	1.06	0.79	1.08	0.81	1.01	0.76	0.1842
Unable to visit loved ones in hospital	0.57	0.77	0.54	0.77	0.62	0.75	0.1113
Family celebrations canceled/restricted	1.04	0.83	1.12	0.83	0.88	0.79	<0.0001
Planned travel/vacations canceled	0.94	0.85	0.96	0.86	0.89	0.81	0.2166
Eating more unhealthy foods	0.81	0.81	0.80	0.83	0.83	0.77	0.5714
Health impacts	1.57	2.10	1.52	2.00	1.67	2.32	0.3215
Increase in health problems not related to pandemic	0.31	0.59	0.32	0.59	0.30	0.59	0.6579
Unable to access medical care for serious condition	0.16	0.45	0.13	0.40	0.24	0.54	0.0013
Delay getting medical care	0.41	0.67	0.42	0.67	0.39	0.67	0.4614
Isolated due to existing health conditions that increase risk of infection	0.46	0.68	0.47	0.69	0.44	0.67	0.6039
Unable to get needed medications	0.23	0.55	0.19	0.51	0.31	0.61	0.0034
Work impacts	1.30	1.74	1.07	1.49	1.78	2.10	<0.0001
Laid off from job	0.31	0.54	0.25	0.50	0.43	0.60	<0.0001
Had to close own business	0.11	0.37	0.09	0.32	0.17	0.46	0.0055
Reduced work hours or furloughed	0.43	0.60	0.37	0.57	0.54	0.65	0.0002
Had to lay-off or furlough employees or people supervised	0.17	0.45	0.12	0.37	0.29	0.58	<0.0001
Hard time making the transition to working from home	0.28	0.54	0.24	0.51	0.36	0.60	0.0034
Finance impacts	1.05	1.65	0.86	1.60	1.44	1.70	<0.0001
Unable to get enough food	0.31	0.63	0.24	0.58	0.45	0.70	<0.0001
Unable to get healthy food	0.34	0.66	0.29	0.62	0.46	0.72	0.0003
Unable to pay important bills like rent or utilities	0.40	0.65	0.33	0.64	0.54	0.68	<0.0001
Family impacts	0.90	1.52	0.82	1.43	1.09	1.67	0.0116
Childcare or babysitting unavailable when needed	0.19	0.48	0.14	0.44	0.28	0.55	0.0001
More conflict with child or children	0.26	0.57	0.23	0.57	0.31	0.59	0.0422
Family or friends had to move into your home	0.13	0.41	0.10	0.37	0.19	0.47	0.0028
Increase in conflict with a partner or spouse	0.32	0.64	0.33	0.66	0.30	0.59	0.4658
Overall pandemic impact	**10.03**	**7.40**	**9.61**	**6.89**	**10.94**	**8.33**	**0.0143**

4 Discussion

4.1 Pandemic impacts

The first objective of this study was to describe the specific COVID-19-related impacts associated with general well-being. *The overall pandemic score, consisting of pandemic experiences faced by respondents and their household members across multiple domains, was negatively related to general well-being, with the subscales of finance, family, health, and work particularly important in unadjusted associations*. These results suggest that general well-being was negatively associated with a variety of pandemic consequences quite apart from getting sick, which should be taken into account when addressing the mental health of the broader population. Research has shown vast mental health impacts related to the pandemic, but only a few studies have examined the relationship between specific aspects of the pandemic and mental health. One such example, a North American study of almost 2,500 adults, identified a variety of pandemic-related stressors, such as personal threat to health, social isolation, financial insecurity, occupational difficulty, and resource scarcity, and found them to be independently associated with depression at follow-up (43). The results of the current study corroborate these findings. Other studies have explored pandemic impacts in specific populations (44–49) but did not focus on mental health. The present study adds to the literature by describing how mental health is related not only to the overall pandemic impact, but to the specific areas of finance, family, health, and work impacts as well. These findings suggest potential targets for interventions related to addressing the psychosocial impacts of pandemics.

TABLE 4 Unadjusted correlates of general well-being.

	N	Estimate	Confidence limits		*p*-value
Race					
White race (vs. Black)	986	1.01	−1.85	3.86	0.4888
Sex					
Male sex (vs. female)	983	10.14	7.50	12.78	<0.0001
Age	986				
18–24 years (vs. 65+ years)		−19.25	−23.44	−15.07	<0.0001
25–44 years (vs. 65+ years)		−19.16	−22.87	−15.45	<0.0001
45–64 years (vs. 65+ years)		−12.46	−16.36	−8.55	<0.0001
Marital status	977				
Married/partnered (vs. single)		4.64	1.98	7.31	0.0006
Income					
Under $50 K/yr (vs. over $50 K/yr)	986	−7.35	−9.99	−4.71	<0.0001
Children					
Any children 0–17 yrs. in HH (vs. none)	986	−5.86	−8.58	−3.15	<0.0001
Pandemic impacts					
Overall pandemic score	986	−1.19	−1.35	−1.03	<0.0001
Buffering characteristics					
High social support (vs. low)	986	15.21	12.73	17.70	<0.0001
High resilience score (vs. low)	986	22.13	19.85	24.42	<0.0001
High social cohesion (vs. low)	870	11.84	9.13	14.56	<0.0001

TABLE 5 Adjusted effects of buffering characteristics on general well-being.

	N	Estimate	Confidence Limits		*p*-value
Model A – Social Support	974				
Overall pandemic impact score		−0.77	−0.96	−0.58	<0.0001
High social support (vs. low)		17.55	13.81	21.28	<0.0001
White race (vs. Black)		−5.71	−8.21	−3.21	<0.0001
Pandemic impact * social support		−0.63	−0.93	−0.33	<0.0001
Model B – Resilience	974				
Overall pandemic impact score		−0.72	−0.90	−0.54	<0.0001
High resilience (vs. low)		22.81	19.43	26.18	<0.0001
White race (vs. Black)		−4.52	−6.83	−2.20	0.0001
Pandemic impact * resilience		−0.57	−0.85	−0.29	<0.0001
Model C – Social Cohesion	862				
Overall pandemic impact score		−0.79	−0.99	−0.60	<0.0001
High social cohesion (vs. low)		14.66	10.60	18.73	<0.0001
White race (vs. Black)		−6.51	−9.27	−3.75	<0.0001
Pandemic impact * social cohesion		−0.73	−1.07	−0.40	<0.0001

All models adjusted for potential confounders of sex, age, marital status, income, and presence of children in the home.

4.2 Buffering effects

The second objective of this study was to identify factors that may mitigate the effects of COVID-19-related impacts on general well-being. We first confirmed that *higher levels of social support, resilience, and social cohesion were all positively associated with general well-being.* In examining whether they were protective in the pandemic impact – general well-being relationship, we found that respondents with higher levels of social support and social cohesion had higher levels of general well-being, holding race constant, but only up to a certain point on the pandemic impact scale, after which these factors ceased to be protective and actually became detrimental to well-being. For resilience, though,

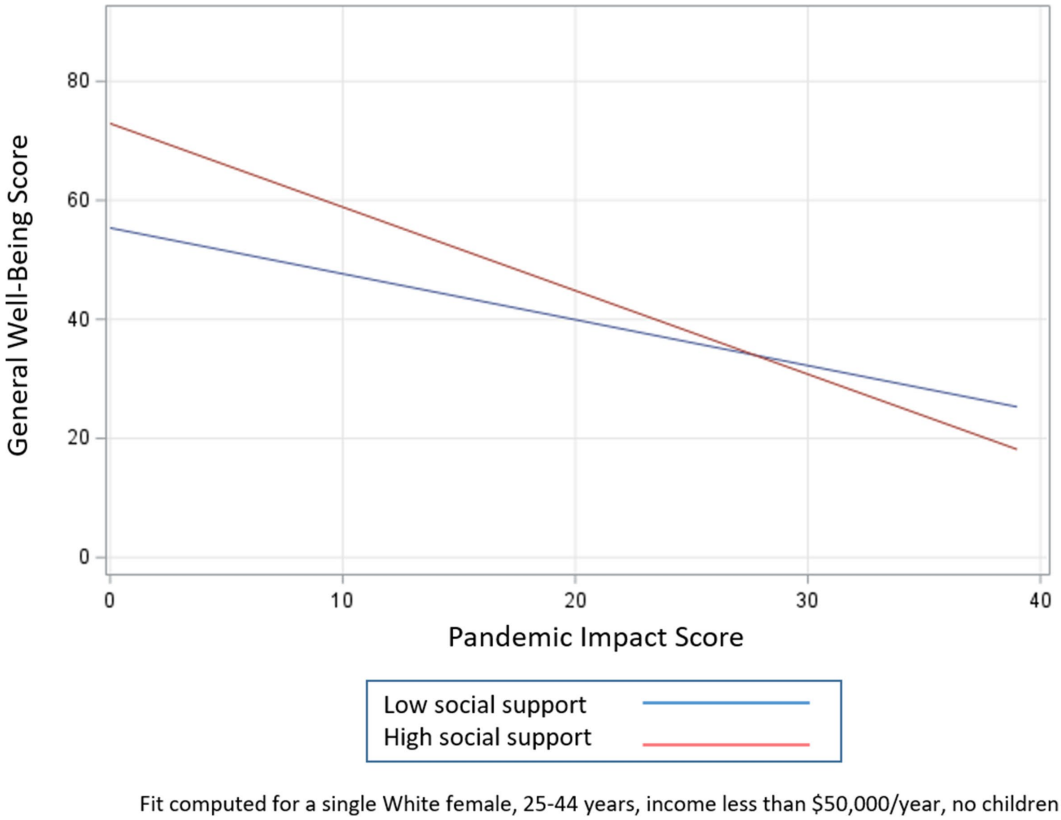

FIGURE 1
Relationship between pandemic impact and general well-being by levels of social support.

we found that respondents with higher levels of resilience had high levels of general well-being, a protective effect that endured (albeit at increasingly smaller levels) regardless of level of pandemic impact.

4.2.1 Application of social support deterioration theory

A possible explanation for this pattern of circumstances can be found in the social support deterioration theory (50), which posits that certain events, such as disasters, result in support *mobilization* that limits psychological distress. However, at the same time, disaster contributes to support *deterioration*, as resources that are initially mobilized are finite and tend to dissipate with time. For example, a community sample of adults was interviewed before and several times after a flood. Respondents had experienced different levels of physical, material, and personal losses as a result of the flood. Study findings supported the hypothesis that disaster victims experienced the impact of the flood both directly through immediate loss and exposure to trauma as well as indirectly through deterioration of their social supports. In other words, the negative effect of the stress (flood) was reflected in the weakening of the capability of support systems to guard against the disaster's detrimental impact (50). It is likely that a similar phenomenon is occurring with the COVID-19 pandemic. The demands of the pandemic likely motivated individuals to activate their support networks and other resources. However, for individuals who experienced more intense pandemic impacts, any support that was initially protective in terms of mental health likely could not stand up to the deeper effects of the crisis. In this case, the pandemic depleted or curtailed the social support that would otherwise protect against negative effects. Social cohesion in our study behaves in a similar fashion, whereby the disaster may be contributing to the deterioration of social capital resources. Evidence from a study of Colombian university students demonstrated a decrease in both cognitive and behavioral social capital between January and August 2020 (51), suggesting that fewer of these resources were available as the pandemic continued and perhaps explaining why social capital, which had been associated with lower levels of depressive symptoms pre-pandemic, was no longer associated with depressive symptoms at the second time point. Although resilience in the present study did not completely deteriorate at higher levels of pandemic impact, its protective effects certainly narrowed. That it did not completely deteriorate may be a result of the relatively small sample size, or it may reflect something about the strength of this particular trait. The decrease in resilience is in line with data from a national study finding that resilience was significantly lower during the pandemic compared to pre-pandemic norms, suggesting that this resource may have also been adversely affected by the pandemic (17). When the effects of the pandemic are more intense, psychosocial resources that were previously beneficial are no longer able to provide the same buffers for mental health.

4.3 Racial disparities

The final objective of the study was to describe racial disparities in the association between pandemic impacts and general well-being.

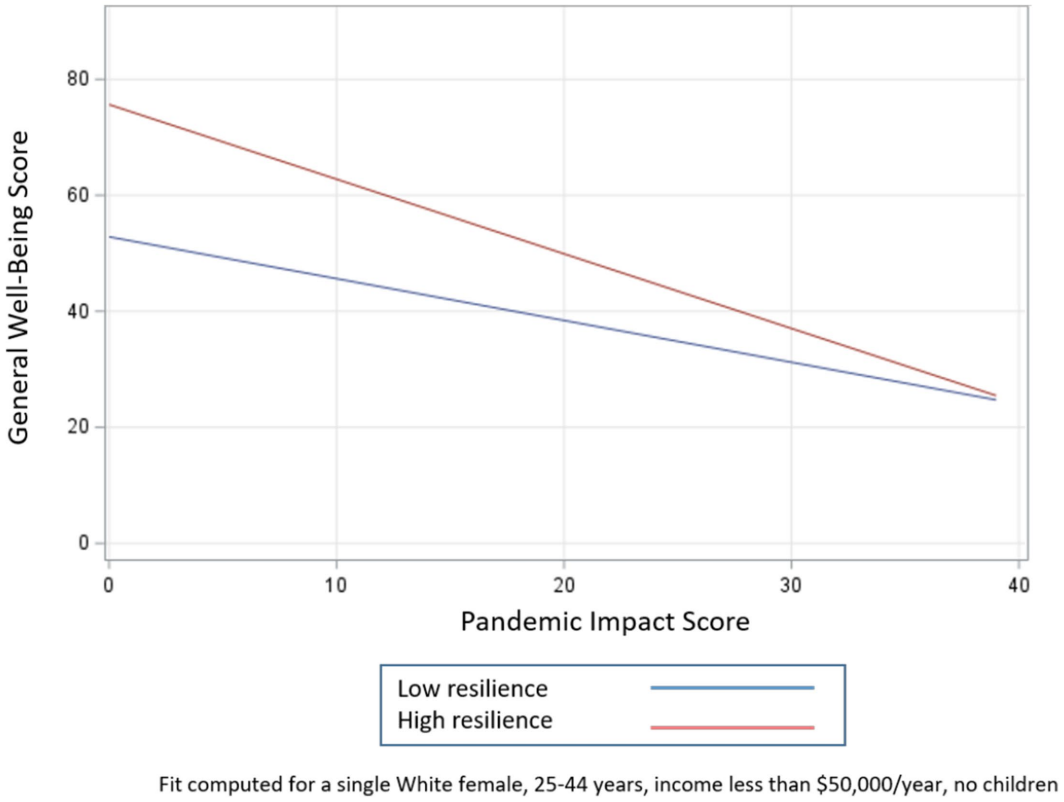

FIGURE 2
Relationship between pandemic impact and general well-being by levels of resilience.

Not surprisingly, *Black respondents tended to experience higher levels of pandemic impacts than White respondents*; these differences were particularly marked for work-related impacts, finance-related impacts, and family-related impacts.

4.3.1 Race and social support

Black respondents in our study also tended to report lower levels of each of the three buffering characteristics of social support, resilience, and social cohesion. It has been well-documented in the disaster literature that racial/ethnic minorities receive less social support than White persons. For example, a study conducted after Hurricane Hugo in 1989 demonstrated that Black residents in hurricane-affected areas of the southern United States received less tangible support than equally affected White disaster victims, and the disaster exposure sharpened their relative disadvantage (52). Extending the disaster analogy to the COVID-19 pandemic, it is not surprising that these disparities are still playing out.

4.3.2 Race and resilience

In contrast to our finding of less resilience among Black compared to White persons, a national study of US respondents defined resilience as more optimism and better mental health and found that Black persons had higher levels of it than their White counterparts throughout the pandemic (53). Similarly, a study of US women in 2011 reported the highest levels of resilience, measured via the Brief Resilience Scale, among Black women compared to women of other race/ethnicities (32). In Louisiana, by contrast, the Behavioral Risk Factor Surveillance System demonstrated lower scores on the Brief Resilience Scale for Black individuals compared to White individuals in 2022, during the COVID-19 pandemic (33). Yet another study of adults in the New York City area conducted after the September 11 terrorist attack found no significant differences between Black and White persons in resilience scores as defined by the number of PTSD symptoms in the first 6 months after the attack (34). The differences in findings between the current study and what is found in the literature may be due to differences in how resilience was measured in each study, the context (disaster, pandemic, or not), or geographic area (United States, deep South, Northeast). Future research on racial differences in resilience should focus on common definitions and contexts.

4.3.3 Race and social cohesion

Black respondents in our study tended to experience lower levels of social cohesion than White respondents. While there is little agreement in the literature surrounding the effects of race on social cohesion, owing to differing conceptualizations of both social cohesion and race (54), some studies have suggested that Blacks experience lower levels of social cohesion than Whites (36). One study of largely segregated neighborhoods in a Midwestern city, that used the same social cohesion measure as the current study, found that majority Black neighborhoods had lower levels of social cohesion than majority White neighborhoods (55). This difference was explained by residents' perceptions about the amount of effort required to change undesirable aspects of the neighborhood. It is possible that other

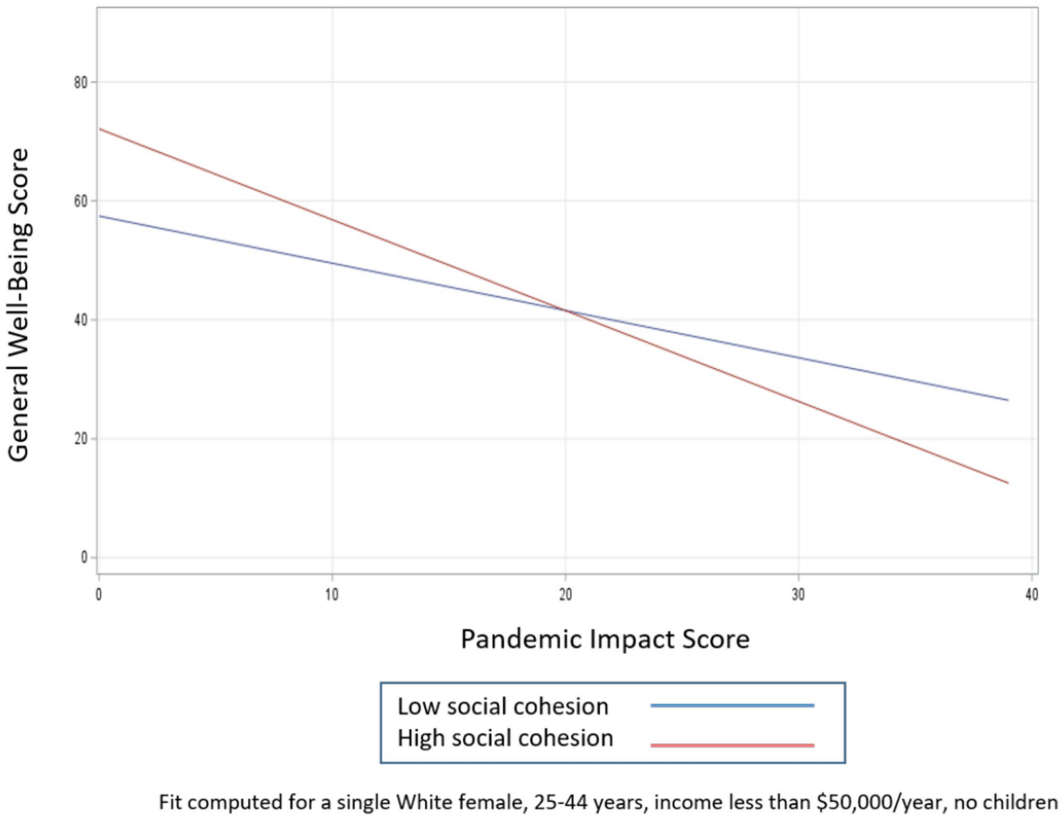

FIGURE 3
Relationship between pandemic impact and general well-being by levels of social cohesion.

TABLE 6 Adjusted effects of buffering characteristics and race on general well-being.

	N	Estimate	Confidence Limits		*p*-value
Model A – Social Support	974				
Overall pandemic impact score		−0.53	−0.78	−0.29	<0.0001
High social support (vs. low)		16.39	12.60	20.18	<0.0001
White race (vs. Black)		−0.81	−4.79	3.17	0.6894
Pandemic impact * social support		−0.52	−0.82	−0.21	0.0011
Pandemic impact * race		−0.48	−0.78	−0.18	0.0020
Model B – Resilience	974				
Overall pandemic impact score		−0.43	−0.65	−0.20	0.0002
High resilience (vs. low)		21.94	18.57	25.31	<0.0001
White race (vs. Black)		1.30	−2.35	4.94	0.4860
Pandemic impact * resilience		−0.47	−0.75	−0.18	0.0012
Pandemic impact * race		−0.56	−0.84	−0.29	<0.0001
Model C – Social Cohesion	862				
Overall pandemic impact score		−0.57	−0.83	−0.30	<0.0001
High social cohesion (vs. low)		13.88	9.79	17.98	<0.0001
White race (vs. Black)		−1.96	−6.36	2.44	0.3825
Pandemic impact * social cohesion		−0.66	−1.00	−0.32	0.0001
Pandemic impact * race		−0.43	−0.75	−0.10	0.0095

All models adjusted for potential confounders of sex, age, marital status, income, and presence of children in the home.

TABLE 7 Adjusted effects of pandemic impact on general well-being by levels of buffering characteristics, stratified by race.

	Estimate	Confidence limits		*p*-value	Estimate	Confidence limits		*p*-value
	N				N			
	White persons				Black persons			
Model A – Social Support	668				306			
Overall pandemic impact score	−1.03	−1.30	−0.77	<0.0001	−0.51	−0.78	−0.24	0.0002
High social support (vs. low)	17.31	12.75	21.88	<0.0001	13.06	6.30	19.83	0.0002
Pandemic impact * social support	−0.49	−0.86	−0.12	0.0097	−0.55	−1.11	−0.003	0.0487
Model B – Resilience	668				306			
Overall pandemic impact score	−1.07	−1.31	−0.83	<0.0001	−0.31	−0.57	−0.05	0.0195
High resilience (vs. low)	21.07	16.98	25.16	<0.0001	22.83	16.88	28.79	<0.0001
Pandemic impact * resilience	−0.33	−0.68	0.02	0.0639	−0.75	−1.24	−0.27	0.0024
Model C – Social Cohesion	605				257			
Overall pandemic impact score	−0.95	−1.21	−0.68	<0.0001	−0.55	−0.83	−0.26	0.0002
High social cohesion (vs. low)	15.80	10.98	20.63	<0.0001	11.07	3.54	18.59	0.0039
Pandemic impact * social cohesion	−0.86	−1.27	−0.45	<0.0001	−0.33	−0.91	0.24	0.2523

All models adjusted for sex, age, marital status, income, and presence of children in the home.

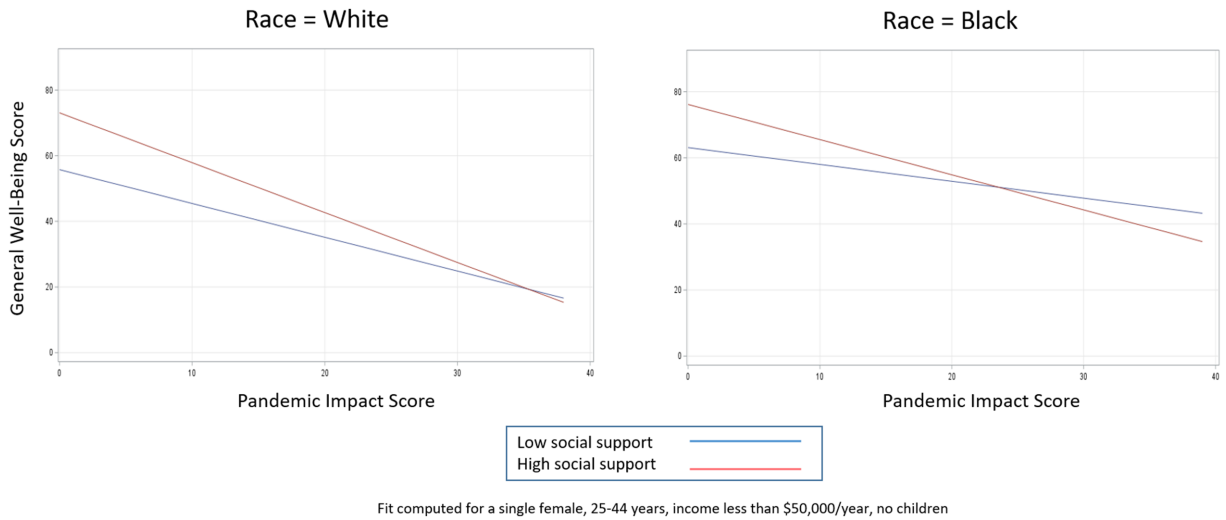

FIGURE 4
Relationship between pandemic impact and general well-being by levels of social support, stratified by race.

neighborhood characteristics as well, such as housing insecurity, could be hindering opportunities for social cohesion. Future avenues of research could explore the specific mechanisms behind the relationships between race and social cohesion.

4.3.4 Race modifies the relationship between pandemic stressors and general well-being

Although no unadjusted relationships were found between race and general well-being in the present study, *race was an important effect modifier of the pandemic-general well-being relationship*.

4.3.4.1 Social support and resilience

For example, both social support and resilience ceased to be protective for general well-being much sooner for Black persons than for White persons. This suggests that the social support deterioration theory mentioned above (50) is particularly salient for Black individuals. While White persons are able to translate high levels of social support and resilience into general well-being regardless of their level of pandemic impact, Black persons show that the buffering ability of these resources is eventually depleted when they are impacted by the pandemic at higher levels. These findings further highlight the deleterious impacts of the pandemic for racial minorities.

4.3.4.2 Social cohesion

With social cohesion, a component of social capital, Black persons tended to fare slightly better than White persons. Black persons with higher levels of social cohesion had higher levels of general well-being

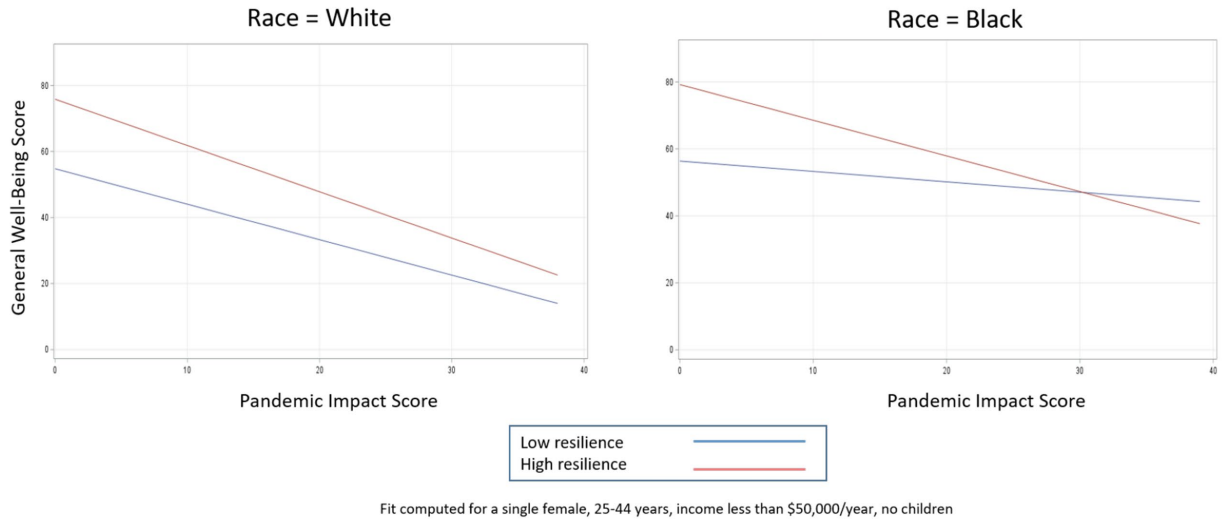

FIGURE 5
Relationship between pandemic impact and general well-being by levels of resilience, stratified by race.

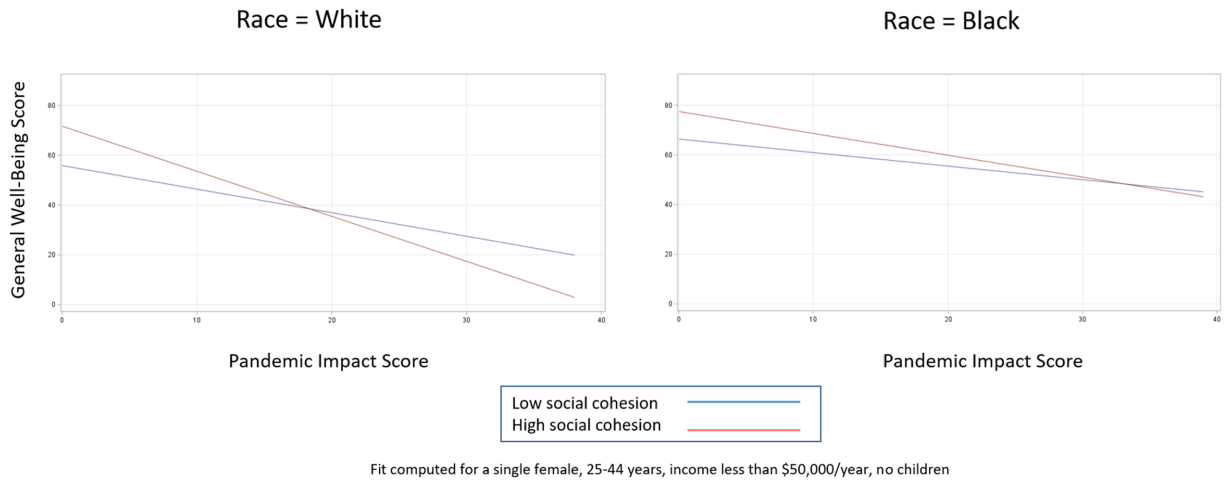

FIGURE 6
Relationship between pandemic impact and general well-being by levels of social cohesion, stratified by race.

across most of the pandemic impact scale, while White persons with higher social cohesion only had better general well-being at the lower ends of the pandemic impact scale. Little research has been conducted on racial differences in social capital, much less how social capital can act as a buffer to mental health during a pandemic. The concepts of bonding, bridging, and linking forms of social capital could be used as a foundation for designing interventions or policies that may mitigate negative pandemic impacts on mental health, though more research is needed to understand how racial differences impact these specific relationships.

4.4 Limitations

A few limitations of this study should be noted. (1) It was a cross-sectional study conducted during the first 6 months of the pandemic. It is possible that as the pandemic has continued and evolved, the nature of its impact may have worsened or even started to improve. Future research on different time periods within the pandemic would help elucidate the nature of its impact on mental health. (2) This study was also unable to include data on pre-pandemic mental health. General well-being measured during the pandemic may have been influenced by pre-pandemic well-being, which could have affected results. (3) The EPII, the measurement tool used to measure pandemic impact, is a relatively new instrument with little data available yet on psychometric properties and optimal scoring procedures, and inconsistent use in the specific items retained. Nevertheless, it is a comprehensive instrument with face validity that adds to our understanding of pandemic impacts. (4) The GWB scale, used to measure the outcome of general well-being for the study, asks about respondents' experiences "during the last month." It is possible that

some recall bias may have occurred in the in respondents' interpretation of the questions' time frame.

5 Conclusion

The COVID-19 pandemic has impacted mental health in unprecedented ways, prompting research to better understand the pathways through which mental health is affected and how racial disparities might influence these pathways, as Black persons tend to be more impacted by the pandemic than White persons. The psychosocial resources of social support, resilience, and social cohesion are important to consider when creating policies and interventions designed to ameliorate the detrimental effects on mental health during a crisis, but these resources can get compromised as the crisis endures, and this can happen differentially for Blacks compared to Whites. Specifically, social support and resilience appear to deteriorate more rapidly for Black persons compared to White persons, while social cohesion appears to deteriorate more rapidly for White persons compared to Black persons. Future research should consider the specific domains of pandemic impact that affect well-being and tailor interventions around them. This study also highlights the importance of evaluating recovery and mitigation interventions in light of cultural contexts, as an intervention may work well for one sub-population but not for another. Other buffering factors should also be identified and explored, including different personality traits, various components of social capital, and even neighborhood environments. Specific causal pathways and hypotheses involving the relationships that may exist between buffering factors could be elucidated as well. For example, living in neighborhoods high in social cohesion may lead to increased individual resilience, which may in turn lead to improved mental health (35). The long-term effects of pandemic-related stressors are also a critically important area of future research. Results from the present study also have implications for current policy and practice. Mitigation and recovery efforts should consider feasibility of interventions across race/ethnicity categories and include culturally sensitive components to bolster identified buffering factors.

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 involving humans were approved by Louisiana State University Health Sciences Center-New Orleans Institutional Review Board. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

AR: Conceptualization, Formal analysis, Investigation, Methodology, Project administration, Supervision, Visualization, Writing – original draft, Writing – review & editing. EO: Formal analysis, Methodology, Supervision, Writing – original draft, Writing – review & editing. TP: Data curation, Formal analysis, Writing – original draft, Writing – review & editing. EP: Conceptualization, Funding acquisition, Investigation, Resources, Writing – original draft, Writing – review & editing.

Funding

The author(s) declare that financial support was received for the research, authorship, and/or publication of this article. This research was supported by the Louisiana State University Health Sciences Center-New Orleans, School of Public Health.

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

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frontiers | Frontiers in Psychology

TYPE Original Research
PUBLISHED 13 August 2024
DOI 10.3389/fpsyg.2024.1396963

OPEN ACCESS

EDITED BY
Gabriele Nibbio,
University of Brescia, Italy

REVIEWED BY
Andreas Stallmach,
University Hospital Jena, Germany
Volker Köllner,
Reha-Zentrum Seehof, Germany

*CORRESPONDENCE
Frits van Osch
✉ fvosch@viecuri.nl

RECEIVED 06 March 2024
ACCEPTED 15 July 2024
PUBLISHED 13 August 2024

CITATION
Claessens G, Gerritzen I, van Osch F, van den Bergh JP, Verberne D, Gach D, van Balen E and van Heugten CM (2024) Prevalence and predictors of persistent cognitive and psychological symptoms in non-hospitalized post-COVID-19 patients seeking care at an outpatient post-COVID-19 clinic.
Front. Psychol. 15:1396963.
doi: 10.3389/fpsyg.2024.1396963

Prevalence and predictors of persistent cognitive and psychological symptoms in non-hospitalized post-COVID-19 patients seeking care at an outpatient post-COVID-19 clinic

Gisela Claessens[1], Iris Gerritzen[2], Frits van Osch[2,3]*, Joop P. van den Bergh[4,5,6], Daan Verberne[1], Debbie Gach[2,5], Eric van Balen[1] and Caroline M. van Heugten[7,8]

[1]Department of Medical Psychology, VieCuri Medical Center, Venlo, Netherlands, [2]Department of Clinical Epidemiology, VieCuri Medical Center, Venlo, Netherlands, [3]Department of Epidemiology, Maastricht University, Maastricht, Netherlands, [4]Department of Internal Medicine, VieCuri Medical Center, Venlo, Netherlands, [5]NUTRIM School of Nutrition and Translational Research in Metabolism, Maastricht University, Maastricht, Netherlands, [6]Department of Internal Medicine, Maastricht University Medical Center +, Maastricht, Netherlands, [7]Department of Neuropsychology and Psychopharmacology, Maastricht University, Maastricht, Netherlands, [8]Limburg Brain Injury Center, Maastricht University, Maastricht, Netherlands

Introduction: There is still much uncertainty about why some people develop persistent cognitive and mental health problems after SARS-CoV-2 infection and require additional care while others do not. In this study, we investigated the cognitive and psychological outcomes of non-hospitalized post-COVID-19 patients referred to an outpatient post-COVID-19 clinic for persistent symptoms more than 3months after infection. Additionally, we aimed to explore the influence of demographic, physical, and personal factors on these outcomes.

Methods: This cross-sectional study was conducted at an outpatient post-COVID-19 clinic located at a prominent clinical teaching hospital in the Netherlands. Participants included non-hospitalized patients referred between 2020 and 2022, more than 3 months after SARS-CoV-2 infection, experiencing persistent symptoms. Main outcome measures included levels of anxiety and depression (Hospital Anxiety and Depression Scale), post-traumatic stress symptoms (PTSS) (Post-traumatic Stress Symptoms Checklist 14), and cognitive symptoms (Checklist for Cognitive and Emotional Consequences). Data analysis employed Spearman correlation and hierarchical multiple regression analyses.

Results: A total of 265 patients (61% female; mean age of 51.7 ± 13.7 years) were included in the study, with an average of 7.6 ± 4.5 months following SARS-CoV-2 infection. Among them, 104 patients (40%) reported high levels of anxiety, 111 patients (43%) showed high levels depressive symptoms, and 71 patients (31%) demonstrated high levels of PTSS. Additionally, 200 patients (79%) reported experiencing more than 2 cognitive symptoms. Bivariate analyses indicated associations between psychiatric history and increased cognitive and psychological symptoms. Multivariate analyses revealed positive associations between physical symptoms and cognitive and psychological symptoms, and catastrophizing thoughts were associated with higher anxiety levels ($\beta = 0.217$,

$p < 0.001$). Conversely, positive refocusing was associated with lower depressive symptoms ($\beta = -0.325$, $p < 0.001$), PTSS ($\beta = -0.290$, $p < 0.001$), and cognitive symptoms ($\beta = -0.220$, $p < 0.001$).

Discussion: Among non-hospitalized COVID-19 patients seeking care for persistent symptoms, approximately one-third reported high levels of psychological symptoms, and more than three-quarter experienced cognitive symptoms. Physical symptoms, psychiatric history, and a tendency to catastrophize were identified as potential risk factors for persistent psychological and cognitive symptoms. Conversely, positive refocusing demonstrated a protective effect. These findings contribute to the understanding of long-term COVID-19 outcomes and emphasize the importance of integrating a biopsychosocial perspective into treatment approaches.

KEYWORDS

COVID-19, adaptation and psychological, mental disorders, cognition, depression, anxiety, delivery of health care, outcome assessment and health care

1 Introduction

Following a SARS-CoV-2 infection, acute symptoms may persist, leading to enduring symptoms thereby posing challenges for the (mental) healthcare system. The impact extends beyond physical symptoms such as fatigue, dyspnea, cough, and headache to encompass psychological and cognitive symptoms (Ballering et al., 2022; Surapaneni et al., 2022). Persistent psychological and cognitive symptoms include depression, anxiety, post-traumatic stress symptoms (PTSS), memory and concentration problems, slowness in thinking, and confusion (Mazza et al., 2020; Evans et al., 2021; Taquet et al., 2021; Fang et al., 2022; Houben-Wilke et al., 2022; Tabacof et al., 2022). A meta-analysis revealed that long-term neurological and neuropsychiatric symptoms were prevalent in both hospitalized and non-hospitalized patients (Premraj et al., 2022). This suggests that neither the initial severity of the SARS-CoV-2 infection nor the necessity for clinical care following infection determines the development of persistent symptoms. Since the majority of post-COVID-19 patients have not required hospitalization, with approximately 135 thousand out of 8.6 million infected individuals in the Netherlands having been admitted to hospitals between 2020 and 2022, it is evident that the non-hospitalized cohort comprises the largest patient group (Dutch National Intensive Care Evaluation, 2023; World Health Organization, 2023).

Identified risk factors for persistent psychological and cognitive symptoms include increasing age, female sex, persistent physical symptoms, medical comorbidities, low income, minority race/ethnicity, and psychiatric history (Michelen et al., 2021; Taquet et al., 2021; Righi et al., 2022; Abramoff et al., 2023; Zakia et al., 2023). Similar patterns are observed in other infectious diseases such as Q fever and Lyme disease, where a subset of individuals experiences persistent symptoms (Reukers et al., 2020; Hündersen et al., 2021). Personal factors, such as pre-existing emotional problems or psychiatric history, along with specific coping styles, predict long-term psychological functioning in these patients (Hill and Frost, 2022; Huiberts et al., 2022). To our knowledge, no studies have explored the combined influence of personal and physical factors on cognitive and psychological functioning among non-hospitalized post-COVID-19 patients. Additionally, few studies have addressed psychological and cognitive functioning of non-hospitalized post-COVID-19 patients necessitating further care for persistent symptoms (Abramoff et al., 2023). Identifying risk factors associated with cognitive and psychological functioning is crucial for understanding the etiology of persistent symptoms, facilitating the prediction of recovery processes, and the formulation of new treatment strategies for managing post-COVID-19 healthcare. Noteworthy for clinicians is the identification of modifiable personal factors, such as coping, which could be targeted in treatment to reduce symptoms and enhance patient resilience (Lemogne et al., 2023).

This study aimed (1) to examine psychological and cognitive functioning of non-hospitalized patients seeking care for long-term symptoms after SARS-CoV-2 infection; and (2) to investigate the independent contribution of demographic, physical, and personal factors on cognitive and psychological functioning post-COVID-19.

2 Materials and methods

2.1 Design and participants

This study employed a single-center, cross-sectional design. The study focused on patients who had experienced a following SARS-CoV-2 infection and sought care at an outpatient post-COVID-19 clinic after being referred by a general practitioner or medical specialist. Initially, referral criteria included patients with persistent fatigue, diminished fitness, and pulmonary symptoms such as exertional dyspnea, thoracic symptoms, or other symptoms,

Abbreviations: 4DSQ, four-dimensional symptom questionnaire; CERQ, cognitive emotion regulation questionnaire; CLCE-24, checklist for cognitive and emotional consequences; COVID-19, coronavirus disease 2019; HADS, hospital anxiety and depression scale; IQR, interquartile range; PTSD, post-traumatic stress disorder; PTSS, post-traumatic stress symptoms; PTSS-14, post traumatic stress symptoms checklist 14.

suspected of a previous SARS-CoV-2 infection. Subsequently, this was revised to include only those with a confirmed SARS-CoV-2 infection more than 3 months ago. Inclusion criteria for the study involved having a proficient command of the Dutch language to complete questionnaires and a willingness to complete the questionnaires. Exclusion criteria were age under 18, hospital admission following SARS-CoV-2 infection, and time since SARS-CoV-2 infection less than 3 months.

2.2 Procedure

Data were collected during visits to the outpatient post-COVID-19 clinic at a prominent clinical teaching hospital in the Netherlands, serving approximately 280,000 inhabitants. After referral by the general practitioner or medical specialist, patients concurrently visited the pulmonologist and internist. Standardized cognitive and psychological questionnaires [Hospital Anxiety and Depression Scale (HADS), Post-traumatic Stress Symptoms Checklist 14 (PTSS-14), and Checklist for Cognitive and Emotional Consequences (CLCE-24)] were provided during or after consultation (Zigmond and Snaith, 1983; van Heugten et al., 2007; Twigg et al., 2008). Patients were requested to return completed questionnaires using an enclosed envelope to the Medical Psychology department. Patients not proficient in Dutch or unwilling to complete the questionnaires did not receive them. Following questionnaire return, a psychologist contacted patients, conveyed the results, and assessed the need for additional psychological treatment for coping with cognitive and/or emotional symptoms. Treatment was recommended for patients experiencing difficulties dealing with such symptoms, initiated or exacerbated after SARS-CoV-2 infection, impacting daily life functioning. Over time, clinical practice prompted the inclusion of the Four-Dimensional Symptom Questionnaire (4DSQ) and Cognitive Emotion Regulation Questionnaire (CERQ) to gain additional insight into physical symptoms and coping styles (Terluin, 1996; Garnefski et al., 2001).

Study data were retrieved from medical records and stored in a COVID-specific hospital database in Castor EDC (Castor, 2019). The study was conducted in accordance with the Medical Ethical Committee of Maastricht University Medical Center+, falling beyond the scope of the Medical Research Involving Human Subjects Act (WMO) (2021–3,059). The study was approved by the local institutional review board. Patients were informed about potential research use of their clinical data and had the option to opt out. Data collection occurred between July 1st 2020, and January 1st, 2023.

2.3 Measures

Demographic characteristics included age, sex, and time between SARS-CoV-2 infection and the post-COVID-19 clinic visit.

The HADS is a self-assessment tool assessing depression and anxiety symptoms (Zigmond and Snaith, 1983). It comprises anxiety (HADS-anxiety) and depression (HADS-depression) subscales, each with seven items. Responses, on a four-point Likert scale (0–3), yield subscale scores ranging from 0 to 21; higher scores indicate more symptoms of anxiety or depression. A cut-off score of ≥8 per subscale indicated clinically relevant symptoms of anxiety or depression (Herrmann, 1997).

The PTSS-14 is a screening questionnaire identifying patients at risk of post-traumatic stress disorder (PTSD) (Twigg et al., 2008). It features 14 items on a seven-point Likert scale (1–7), with scores ranging from 14 to 98; higher scores indicate more PTSS. Possible traumatic events were assessed by evaluating nightmares, anxiety and panic attacks, severe pain, and breathing difficulties and feelings of choking during the period of SARS-CoV-2 infection. The questions were slightly modified to specify the illness period of the SARS-CoV-2 infection. A cut-off score of ≥45 indicated high levels of PTSS (Twigg et al., 2008).

The CLCE-24 comprises 24 questions screening for cognitive and emotional symptoms, with 13 questions specifically assessing the absence or presence of cognitive symptoms (CLCE-cognition) and 1 item assessing the presence or absence of fatigue (CLCE-fatigue). Higher scores indicate more cognitive problems experienced in daily life (range 0–13) (van Heugten et al., 2007). We used a cutoff >2 based on mean of 1.9 (standard deviation = 1.9) in healthy controls (van Rijsbergen et al., 2015).

The 4DSQ measures the tendency to experience distress, somatization, depression, and anxiety (Terluin, 1996). For this study, only data from the somatization subscale, assessing physical symptoms over the past weeks, were used. The somatization subscale comprises 16 items (scores range 0–32), with scores between 11 and 20 indicating moderate physical symptoms and scores >20, used as cut-off in this study, indicating severe physical symptoms (Terluin et al., 2008).

The CERQ measures patients' generally used cognitive coping strategies (Garnefski et al., 2002). It is a 36-item questionnaire featuring nine conceptually distinct subscales (Garnefski et al., 2001). Items are scored on a five-point Likert scale (1–5), with subscale scores ranging from 4 to 20. Higher scores indicated more frequent use of the coping strategy. Normative data was obtained from the CERQ manual (Garnefski et al., 2002).

2.4 Statistical analysis

The study population was described using means (SD) and medians (IQR). Numbers and percentages were reported for binary variables and variables with cut-off values. We presented both raw scores and *z*-scores of the CERQ.

Bivariate analyses, using Spearman correlation coefficients with Bonferroni correction for multiple comparisons (0.05/10 personal factors), were used to calculate associations between personal factors (i.e., psychiatric history and CERQ subscales) and cognitive and psychological outcomes. Four hierarchical multiple regression analyses were conducted to assess associations between demographic, physical, and personal factors and psychological and cognitive outcomes. Dependent variables were scores on HADS-anxiety, HADS-depression, PTSS-14, and CLCE-cognition. Age, sex, and time since SARS-CoV-2 infection were added as independent variables to the first block, and physical factors (4DSQ score) to the second block. Personal factors (CERQ subscales) found significant in bivariate analyses were added to the third block. Psychiatric history was omitted in the multivariate analyses due to missing data and lack of power. After applying the Bonferroni correction (0.05/4),

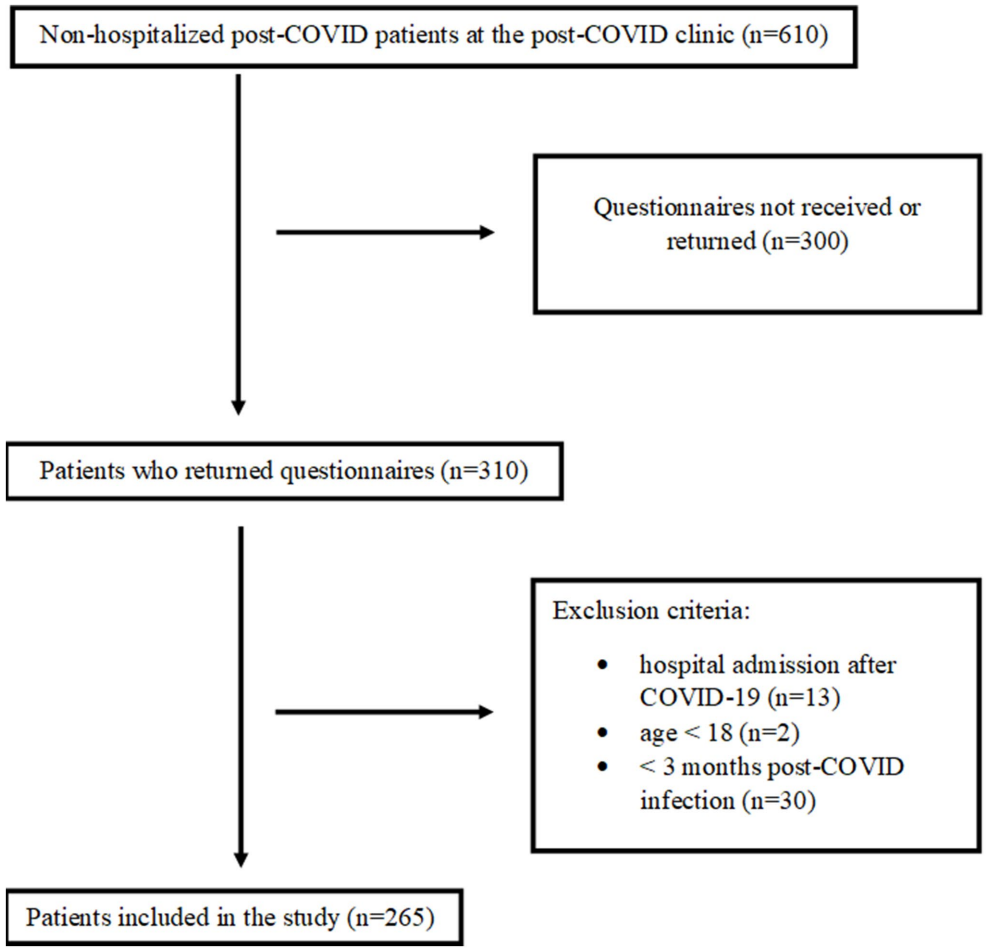

FIGURE 1
Flowchart for patient inclusion.

the alpha level was set at 0.01 for multivariate analyses. Regression analysis assumptions were met for each model. IBM SPSS Statistics, version 26, was used for data analysis.

3 Results

3.1 Participants

Figure 1 indicates that 610 patients were referred to the post-COVID-19 clinic during the study period. Of these patients, 310 (51%) returned the questionnaires, and 45 patients were excluded. In total, data from 265 patients were used in this study.

Table 1 presents the characteristics of the patients included in this study. Approximately 1 in 5 patients had a known psychiatric history (22%). One third of the patients (36%) were indicated for psychological treatment for their symptoms and visited the Medical Psychology department.

Table 2 outlines the scores on the physical and personal variables and outcome measures. Of the patients, 95% reported the presence of fatigue symptoms on the CLCE-fatigue. More than half of the patients (53%) who completed the 4DSQ reported scores above the cut-off. Approximately, between 30 and 40% scored above cut-off values on the HADS-anxiety, HADS-depression, and PTSS-14. Over three quarters of patients (79%) reported more than two cognitive symptoms on the CLCE-cognition. The most common cognitive

TABLE 1 Patient characteristics ($n = 265$).

Variable	Mean (SD)/Median (IQR)/*n* (%)
Sex, male	103 (39)
Age in years	
Mean (SD)	51.7 (13.7)
Median (IQR)	53.0 (17.0)
Time since infection in months	
Mean (SD)	7.6 (4.5)
Median (IQR)	6.1 (4.9)
3–6 months	122 (46)
>6 months	143 (54)
Psychological history (yes)	58 (22)
Missing	36 (14)
Indication for psychological treatment (yes)	96 (36)

TABLE 2 Descriptive of physical and personal variables and outcome measures ($n = 265$).

Measures and domains	Range in data	*n*	Mean (SD)	Median (IQR)	*n* (%) above/below cut-off
Physical and personal variables					
4DSQ	1–32	151	13.7 (7.0)	13.0 (10.0)	140 (53)
CLCE-fatigue		262			248 (95)
CERQ					
Self-blame	0–19	149	6.4 (3.3)	5.0 (4.0)	2 (1) * 5 (3) †
Acceptance	0–20	149	11.3 (3.7)	11.0 (5.0)	7 (5) * 5 (3) †
Rumination	0–19	149	9.4 (4.0)	9.0 (6.0)	2 (1) * 5 (3) †
Positive refocusing	0–20	149	11.2 (4.2)	11.0 (6.0)	2 (1) * 15 (10) †
Planning	0–20	149	12.7 (4.2)	13.0 (6.0)	7 (5) * 0 †
Positive reappraisal	0–20	149	10.8 (4.5)	10.0 (7.0)	11 (7) * 0 †
Putting thing in perspective	0–20	149	12.5 (4.6)	13.0 (7.0)	2 (1) * 7 (5) †
Catastrophizing	0–18	149	6.0 (2.9)	5.0 (3.0)	2 (1) * 13 (9) †
Other blame	0–18	149	5.4 (2.6)	4.0 (2.0)	2 (1) * 6 (4) †
Outcome measures					
HADS-anxiety	0–18	259	6.7 (4.3)	6.0 (7.0)	104 (40)
HADS-depression	0–20	259	7.0 (4.6)	7.0 (7.0)	111 (43)
PTSS-14	14–74	233	35.8 (14.5)	34.0 (22.0)	71 (31)
CLCE-cognition	0–13	254	5.8 (3.5)	6.0 (6.0)	200 (79) ‡

* <2 SD as compared to normative data.
† > 2 SD as compared to normative data.
‡ > 2 cognitive symptoms.

symptoms were mental slowness (72%), difficulties in paying attention (74%), and remembering new information (75%).

3.2 Associations and predictors of anxiety

Bivariate analyses revealed that six coping subscales were significantly associated with higher anxiety scores: a higher tendency toward self-blame ($r = 0.320$, $p < 0.001$), rumination ($r = 0.484$, $p < 0.001$), catastrophizing ($r = 0.411$, $p < 0.001$), and other-blame ($r = 0.298$, $p < 0.001$), and a lower tendency toward positive refocusing ($r = -0.315$, $p < 0.001$) and positive reappraisal ($r = -0.228$, $p < 0.001$). Multivariate analyses showed that demographic factors explained 5.2% of the variance in anxiety (step 1). Physical symptoms explained an additional 35.8% of the variance in anxiety (F change = 86.222, $p < 0.001$) (step 2). Personal factors (coping) explained an additional 15.2% of the variance in anxiety (F change = 7.862, $p < 0.001$). In the final model, more physical symptoms ($\beta = 0.482$, $p < 0.001$) and a higher tendency toward catastrophizing ($\beta = 0.217$, $p < 0.01$) were significantly associated with higher anxiety scores ($R^2 = 0.562$) (Table 3).

3.3 Associations and predictors of depression

Bivariate analyses showed that psychiatric history and five coping subscales were significantly associated with higher depression scores: psychiatric history ($r = 0.216$, $p < 0.001$), a higher tendency toward self-blame ($r = 0.246$, $p < 0.001$), rumination ($r = 0.441$, $p < 0.001$), catastrophizing ($r = 0.406$, $p < 0.001$), and other-blame ($r = 0.232$, $p < 0.001$), and a lower tendency toward positive refocusing ($r = -0.406$, $p < 0.001$). Multivariate analyses demonstrated that demographic factors explained 6.8% of the variance in depression (step 1). Physical factors explained an additional 21.7% of the variance in depression (F change = 43.128, $p < 0.001$) (step 2). Personal factors (coping) explained an additional 16.9% of the variance in depression (F change = 8.477, $p < 0.001$) (step 3). In the final model, more physical symptoms ($\beta = 0.367$, $p < 0.001$) and a lower tendency toward positive refocusing

TABLE 3 Associations and predictors of anxiety and depression ($n = 147$).

Outcome	HADS-anxiety				HADS-depression			
	Bivariate (rs)	Multivariate (β)			Bivariate (rs)	Multivariate (β)		
Predictor		Step 1	Step 2	Step 3		Step 1	Step 2	Step 3
Age		−0.168	−0.031	−0.033		−0.127	−0.019	−0.013
Sex		−0.038	−0.046	−0.015		−0.081	−0.088	−0.062
Time since infection		0.156	0.127	0.053		0.223†	0.199†	0.167
Physical symptoms		NE	0.615†	0.482†		NE	0.479†	0.367†
Psychiatric history	0.142				0.216*			
Self-blame	0.320*	NE	NE	0.059	0.246*	NE	NE	0.059
Acceptance	0.076	NE	NE	NE	0.089	NE	NE	NE
Rumination	0.484*	NE	NE	0.093	0.441*	NE	NE	0.117
Positive Refocusing	−0.315*	NE	NE	−0.118	−0.406*	NE	NE	−0.325†
Planning	−0.002	NE	NE	NE	0.009	NE	NE	NE
Positive Reappraisal	−0.228*	NE	NE	−0.178	−0.208	NE	NE	NE
Putting into Perspective	−0.091	NE	NE	NE	−0.156	NE	NE	NE
Catastrophizing	0.411*	NE	NE	0.217†	0.406*	NE	NE	0.137
Other-blame	0.298*	NE	NE	0.005	0.232*	NE	NE	−0.081
R^2		0.052	0.410	0.562		0.068	0.285	0.454
Adjusted R^2		0.032	0.393	0.530		0.048	0.265	0.418

NE, not entered.
*Bivariate analyses: $p \leq 0.005$.
†Multivariate analyses: $p \leq 0.01$.

($\beta = -0.325$, $p < 0.001$) were the only independent factors significantly associated with higher depression scores ($R^2 = 0.454$) (Table 3).

3.4 Associations and predictors of PTSS

Bivariate analyses showed that psychiatric history and four coping subscales were significantly associated with higher PTSS scores: psychiatric history ($r = 0.211$, $p < 0.001$), a higher tendency toward rumination ($r = 0.481$, $p < 0.001$), catastrophizing ($r = 0.376$, $p < 0.001$), and other-blame ($r = 0.266$, $p < 0.01$), and a lower tendency toward positive refocusing ($r = -0.354$, $p < 0.001$). Multivariate analyses demonstrated that demographic factors explained 6.4% of the variance in PTSS (step 1). Physical factors explained an additional 30.7% of the variance in PTSS (F change = 61.539, $p < 0.001$) (step 2). Personal factors (coping) explained an additional 12.8% of the variance in PTSS (F change = 7.779, $p < 0.001$) (step 3). In the final model, more physical symptoms ($\beta = 0.428$, $p < 0.001$) and a lower tendency toward positive refocusing ($\beta = -0.290$, $p < 0.001$) were the only independent variables significantly associated with higher PTSS scores ($R^2 = 0.499$) (Table 4).

3.5 Associations and predictors of cognitive symptoms

According to bivariate analyses, psychiatric history ($r = 0.210$, $p < 0.001$), a higher tendency toward rumination ($r = 0.230$ $p = 0.006$), and a lower tendency toward positive refocusing ($r = -0.267$, $p = 0.001$) were significantly associated with more cognitive symptoms. Multivariate analyses showed that demographic factors explained 3.4% of the variance in cognitive symptoms (step 1). Physical factors explained an additional 21.8% of the variance in cognitive symptoms (F change = 40.463, $p < 0.001$) (step 2). Personal factors (coping) explained an additional 4.8% of the variance in cognitive symptoms (F change = 4.675, $p = 0.011$) (step 3). In the final model, more physical symptoms ($\beta = 0.444$, $p < 0.001$) and a lower tendency toward positive refocusing ($\beta = -0.220$, $p = 0.003$) were significantly associated with more cognitive symptoms ($R^2 = 0.330$) (Table 4).

4 Discussion

The findings of our study revealed prevalence rates of 40% for anxiety, 42% for depression, 31% for PTSS, and 79% for more than two cognitive symptoms in non-hospitalized patients more than 3 months following SARS-CoV-2 infection. These patients sought care at an outpatient post-COVID-19 clinic. Patients with a psychiatric history reported more depressive symptoms, PTSS, and cognitive symptoms. After accounting for demographic factors, both physical and personal factors explained additional variance in outcomes. More physical symptoms were associated with increased cognitive and psychological symptoms. A greater tendency toward catastrophizing correlated significantly with higher levels of anxiety, while a higher tendency toward positive refocusing was

TABLE 4 Associations and predictors of PTSS ($n = 131$) and cognitive symptoms ($n = 144$).

	PTSS-14				CLCE-cognition			
	Bivariate (rs)	Multivariate (β)			Bivariate (rs)	Multivariate (β)		
		Step 1	Step 2	Step 3		Step 1	Step 2	Step 3
Age		−0.097	−0.018	−0.002		−0.105	−0.008	0.004
Sex		−0.011	−0.063	−0.033		0.032	0.022	0.048
Time since infection		0.234†	0.188†	0.142		0.149	0.126	0.110
Physical symptoms		NE	0.564*	0.428†		NE	0.477†	0.444†
Psychiatric history	0.211*				0.210*			
Self-blame	0.176	NE	NE	NE	0.009	NE	NE	NE
Acceptance	0.162	NE	NE	NE	0.049	NE	NE	NE
Rumination	0.481*	NE	NE	0.215	0.230*	NE	NE	0.024
Positive Refocusing	−0.354*	NE	NE	−0.290†	−0.267*	NE	NE	−0.220†
Planning	0.019	NE	NE	NE	0.087	NE	NE	NE
Positive Reappraisal	−0.193	NE	NE	NE	−0.091	NE	NE	NE
Putting into Perspective	−0.115	NE	NE	NE	−0.090	NE	NE	NE
Catastrophizing	0.376*	NE	NE	0.004	0.179	NE	NE	NE
Other-blame	0.266*	NE	NE	0.018	0.059	NE	NE	NE
R^2		0.064	0.371	0.499		0.034	0.252	0.300
Adjusted R^2		0.042	0.351	0.466		0.014	0.231	0.269

NE, not entered.
*Bivariate analyses: $p \leq 0.005$.
†Multivariate analyses: $p \leq 0.01$.

associated with lower levels of depressive symptoms, PTSS, and cognitive symptoms.

The prevalence rates for psychological symptoms observed in this study exceeded those in the general population in the Netherlands pre-COVID, with reported prevalence rates of 9, 15, and 4% for anxiety, depression, and PTSS, respectively (Bronner et al., 2009; ten Have et al., 2023). Furthermore, around one-third of the patients were clinically indicated for psychological treatment. It should be noted that patients in the present study actively sought help in a specialized post-COVID-19 outpatient clinic for persistent physical symptoms following SARS-CoV-2 infection and actively answered questionnaires after the visit, leading to a selected study population. Nevertheless, a growing body of research highlights the increased prevalence of anxiety, depression, and PTSS in the post-acute and chronic phases following SARS-CoV-2 infection, even among non-hospitalized patients (Houben-Wilke et al., 2022; Righi et al., 2022; Zakia et al., 2023). In addition to persistent psychological symptoms, the study showed that almost 80% of patients reported persistent cognitive symptoms following SARS-CoV-2 infection, in line with previous research (Surapaneni et al., 2022). A meta-analysis highlighted fatigue, cognitive symptoms (brain fog, memory and attention problems), and sleep disturbances as prevalent problems 3 months post-COVID-19 infection, affecting almost one-third of the patients (Premraj et al., 2022). However, subjective cognitive symptoms do not necessarily indicate the presence of cognitive impairments. Among formerly hospitalized COVID-19 patients, Klinkhammer et al. (2023) found that 8–10 months post-discharge, 62% of ICU and general ward survivors reported three or more cognitive complaints, whereas standard neuropsychological testing revealed cognitive dysfunction in only 12% of patients. Discrepancies between subjective cognitive symptoms and cognitive impairment have been demonstrated across various patient populations, including stroke (van Rijsbergen et al., 2014), Lyme disease (Berende et al., 2019), and psychiatry (Groenman et al., 2022). Nevertheless, it should be noted that a lack of cognitive impairment in formal neuropsychological testing does not exclude the possibility of increased cognitive difficulties in daily life.

As anticipated, we found a significant association between physical symptoms and increased cognitive and psychological symptoms post-COVID, which is in line with Righi et al. (2022), showing a positive association between persistence of self-reported physical symptoms 9 months following SARS-CoV-2 infection and psychological distress. While the direction of influence remains unclear, it is plausible that physical symptoms contribute to cognitive and psychological symptoms, or vice versa. Symptoms of anxiety, depression, and PTSS often include physical symptoms, and patients with cognitive symptoms may experience cognitive overload, triggering a stress response with physical symptoms (American Psychiatric Association, 2013; Chu et al., 2023). Additionally, while studies have found varying associations between cognitive testing and depressive symptoms following SARS-CoV-2 infection (Kupferschmitt et al., 2023; Morawa et al., 2023), there is potential overlap between subjective perceptions of cognitive symptoms and depression, which could introduce bias due to concurrent depression. Similar associations have been observed in other patient populations, such as stroke (Nijsse et al., 2017), and among COVID-19 ICU survivors (Fjone et al., 2024). According to the DSM-V, decreased concentration

is considered one of the symptoms of depression, alongside depressed mood and/or loss of interest or pleasure. Cognitive symptoms have been linked to increased depressive symptoms, greater reported functional impairment, and a decreased likelihood of returning to full-time employment post-COVID-19 (Jaywant et al., 2024). Furthermore, fatigue is frequently reported as a persistent symptom following SARS-CoV-2 infection, impacting both mood and cognitive functioning (Klinkhammer et al., 2024).

The present study underlines the importance of personal factors, including psychiatric history and coping, on psychological and cognitive outcomes. The association between psychiatric history and psychopathology has been shown previously (De Lorenzo et al., 2020; Mazza et al., 2020; Özdin and Bayrak Özdin, 2020; Huarcaya-Victoria et al., 2023), suggesting that individuals with past psychiatric illnesses may be more vulnerable to developing persistent symptoms. Coping strategies were associated with cognitive and psychological symptoms in the expected direction (Garnefski et al., 2001). Theoretically maladaptive strategies (rumination, catastrophizing, and blaming self and others) were linked to more symptoms, while theoretically adaptive strategies (positive reappraisal and positive refocusing) were associated with fewer symptoms. Among these coping strategies, only positive refocusing and catastrophizing were independently associated with outcomes, even after considering demographic and physical factors. While no studies have specifically explored the impact of coping on psychological and cognitive symptoms in post-COVID-19 patients, coping, along with other personal factors such as personality characteristics and resilience, has been linked to well-being and distress during the COVID pandemic in the general population (Zager Kocjan et al., 2021; Starcevic and Janca, 2022). Moreover, studies have consistently shown the influence of coping strategies on well-being in infectious diseases like Lyme disease and chronic illnesses such as multiple chronic conditions (Cheng et al., 2020; Huiberts et al., 2022). This underscores the importance of incorporating personal factors as risk factors when predicting outcomes.

4.1 Study limitations and strengths

One limitation is the use of regular clinical data, resulting in some missing variables. Missing data also occurred because not all variables were collected throughout the complete study period. No drop-out analysis was conducted because, in accordance with Dutch medical ethics regulations, if participants have not actively consented to the use of their data for research purposes—such as by not returning the questionnaires—this data may not be used or reported. Despite this limitation, the study included a large number of patients, ensuring sufficient power. Additionally, the absence of a specific questionnaire to assess COVID-19 symptomatology is acknowledged. However, many symptoms captured by the 4DSQ, including shortness of breath and muscle aches, overlap with physical symptoms post-COVID-19 (World Health Organization, 2022). Finally, we assessed cognitive symptoms using a questionnaire rather than cognitive testing. The data were collected as part of standard care. Cognitive testing has not been part of standard care for patients with post-COVID-19 syndrome.

A notable strength of this study lies in the inclusion of non-hospitalized patients facing challenges in their daily lives due to persistent post-COVID-19 symptoms, actively seeking additional care, thereby representing a substantial patient population. Within this cohort, we explored both physical and psychosocial risk factors—a distinctive approach that opens important avenues for future research and holds implications for clinical practice.

4.2 Future research and recommendations for clinical practice

Future research on persistent cognitive and psychological symptoms post-COVID-19 should include psychosocial factors, such as coping in addition to biomedical factors. From a cognitive-behavioral perspective it can be hypothesized that both cognitive coping (thoughts and beliefs) and behavioral coping influence outcomes. Exploring whether adding behavioral coping enhances prediction models of persistent symptoms is interesting, as cognitive coping may precede behavioral coping, with catastrophizing potentially leading to avoidance behavior, decreased activity levels, and lower quality of life (Vlaeyen and Linton, 2000). Additionally, it would be interesting to assess not only symptoms as outcomes but also levels of participation. More specifically, inability to work is common in patients admitted to a rehabilitation clinic, with almost 50% of patients reporting at least 100 days of sick leave in the past year (Kupferschmitt et al., 2023). Inability to work can have a multifaceted impact on individuals, affecting their financial, physical, emotional, and social well-being. Identifying which symptoms, including cognitive, psychological, and physical symptoms, as well as personal and social factors, are associated with participation levels can provide important insights for treatment (World Health Organization, 2001).

The study emphasizes the need to shift from a purely biomedical to a more comprehensive biopsychosocial approach in clinical practice, focusing on alternative risk factors. This approach allows for more precise referrals to psychological treatment. While it is not possible or desirable for everyone to receive treatment, it is crucial that individuals experiencing symptoms disrupting daily life do receive treatment. At present, there is no evidence-based treatment for persistent symptoms post-COVID-19. Tailoring interventions to address individual needs and incorporating modifiable factors such as coping strategies, could be beneficial. Cognitive-behavioral therapies, including second or third-wave approaches such as cognitive-behavioral therapy and acceptance and commitment therapy, have proven effective in enhancing adaptive thinking patterns and behaviors. These interventions contribute to improving psychological flexibility and enhancing the quality of life in patients with chronic illnesses (Gregg et al., 2007; Hind et al., 2014; Feldmann et al., 2021). Such interventions merit consideration for addressing post-COVID-19 symptoms. Notably, for post-COVID-19 fatigue, cognitive-behavioral therapy has shown effectiveness compared to standard care, offering a potential intervention avenue (Kuut et al., 2023).

5 Conclusion

A third of non-hospitalized COVID-19 patients seeking outpatient post-COVID-19 care experience persistent psychological symptoms, while three-quarter deal with cognitive symptoms.

Physical symptoms, psychiatric history, high catastrophizing thoughts, and low positive refocusing are associated with long-term symptoms. The study sheds light on the mental health status of non-hospitalized patients with prolonged symptoms after COVID-19, emphasizing the potential profound impact on cognitive and psychological functioning. Recognizing at-risk patients with persistent symptoms can lead to better-tailored referrals and treatment, improving cognitive and psychological well-being, and reducing healthcare costs.

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 humans were approved by Medical Ethical Committee of Maastricht University Medical Center+. The studies were conducted in accordance with the local legislation and institutional requirements. The ethics committee/institutional review board waived the requirement of written informed consent for participation from the participants or the participants' legal guardians/next of kin. This study is part of a larger study in which also hospitalized patients were included at hospital admission and follow up. Given the observational nature of the study, coupled with the urgency of collecting baseline data in the acute setting, the Medical Ethical Committee of Maastricht University Medical Centre granted a waiver of informed consent. Subsequently, a waiver for medical ethical review was obtained for follow-up data collection. Patients attending the outpatient clinic were informed about the use of their regularly collected clinical data for research and given the option to opt out (approval number: METC 2021-3059).

Author contributions

GC: Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Conceptualization. IG: Writing – review & editing, Data curation. FO: Formal analysis, Data curation, Writing – review & editing, Methodology, Funding acquisition. JB: Writing – review & editing. DV: Writing – review & editing, Data curation. DG: Writing – review & editing. EB: Writing – review & editing, Conceptualization. CH: Writing – review & editing, Supervision, Methodology, Funding acquisition, Conceptualization.

Funding

The author(s) declare that financial support was received for the research, authorship, and/or publication of this article. This research received financial support from the Science and Innovation Fund of VieCuri Medical Center, the Netherlands (grant number: E.22.32.001-6).

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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frontiers | Frontiers in Public Health

TYPE Original Research
PUBLISHED 16 August 2024
DOI 10.3389/fpubh.2024.1408746

OPEN ACCESS

EDITED BY
Gabriele Nibbio,
University of Brescia, Italy

REVIEWED BY
Babita Pande,
All India Institute of Medical Sciences Raipur, India
Nana Jiao,
Arizona State University, United States
Yong-Bo Zheng,
Peking University Sixth Hospital, China

*CORRESPONDENCE
Qiguo Lian
✉ qglian@fudan.edu.cn

RECEIVED 28 March 2024
ACCEPTED 06 August 2024
PUBLISHED 16 August 2024

CITATION
Chen Z, Li R, Liu Y and Lian Q (2024) Sufficient sleep and its contributing factors among high school students during the COVID-19 pandemic: results from adolescent behaviors and experiences survey.
Front. Public Health 12:1408746.
doi: 10.3389/fpubh.2024.1408746

Sufficient sleep and its contributing factors among high school students during the COVID-19 pandemic: results from adolescent behaviors and experiences survey

Zhengyang Chen[1], Ruili Li[2], Yuexi Liu[3] and Qiguo Lian[4]*

[1]Preventive Care Department, Jiangyou Fifth People's Hospital, Sichuan, China, [2]Children Health and Development Department, Capital Institute of Pediatrics, Beijing, China, [3]The Second Clinical Medical College, Dalian Medical University, Dalian, China, [4]NHC Key Lab of Reproduction Regulation, Shanghai Institute for Biomedical and Pharmaceutical Technologies, Shanghai, China

Background: The COVID-19 pandemic has caused profound changes in adolescent lives, including school closures, social isolation, family economic hardship, and sleep schedule. We aimed to assess the risk and protective factors of sufficient sleep among adolescents during COVID-19.

Methods: We conducted secondary analysis based on the cross-sectional school-based Adolescent Behaviors and Experiences Survey in 2021 (n = 7,705). The ABES collected information on health-related experiences and behaviors during COVID-19. The outcome was sufficient sleep (eight and more hours of sleep on the average school night). The contributing factors included demographic, mental health, and adverse experiences indicators. We estimated the prevalence of sufficient sleep within each factor, and examined their associations using Chi-square test. We further investigated the contributing factors of sufficient sleep using multivariate logistic regression and reported the adjusted odds ratios (AORs) and 95% confidence intervals (CIs).

Results: During January–June 2021, 23.5% of the U.S. high school students reported getting sufficient sleep. The multivariate logistic regression indicated that younger age (AOR, 2.04; 95%CI, 1.59–2.62), heterosexual identity (AOR, 1.61; 95%CI, 1.19–2.18), no poor mental health during the past 30 days (AOR, 1.37; 95%CI, 1.03–1.82), no persistent feelings of sadness or hopelessness (AOR, 1.34; 95%CI, 1.09–1.66), no food and nutrition insecurity (AOR, 1.47; 95%CI, 1.17–1.85), never been abused by a parent emotionally (AOR, 1.38; 95%CI, 1.16–1.64), and no schoolwork difficulty (AOR, 1.24; 95%CI, 1.01–1.51) were associated with sufficient sleep.

Conclusion: We estimated the national prevalence of adolescent sufficient sleep during the COVID-19 pandemic and found that younger students, sexual heterosexual students, and students without certain mental health conditions or adverse experiences are at higher likelihood of sufficient sleep. These findings can help develop effective interventions on sleep duration in the response to a possible future pandemic caused by Disease X.

KEYWORDS

sufficient sleep, COVID-19, adolescents, adolescent behaviors and experiences survey, mental health

Introduction

The COVID-19 pandemic has significantly impacted adolescent health worldwide in multifaceted ways, and the impact can be both negative and positive (1). Adolescents have unique developmental needs during the pandemic. The vast majority of research has been on the negative impacts of the COVID-19 pandemic. As a result of school closures, social distancing and the interruption of study are especially challenging for adolescent students (1, 2). In addition to depression and suicide concerns and psychosocial adjustments (3–5), adolescents are also venerable to domestic violence (5) and abuse (6).

Sleep is a core behavior of human being, especially for adolescents. Insufficient sleep poses a significant and multifaceted set of health risks in adolescents, including school performance, mental health and brain structure (7, 8). The positives of the COVID-19 pandemic for adolescents include improvements in family support and increases in sleep duration (9, 10). However, exiting studies, including cross-sectional and longitudinal design (sample size ranged from 590 to 8,972), on the changes in sleep duration among adolescents during the pandemic have led to mixed results (10–14). For example, although a few studies demonstrated that adolescents usually reported longer sleep duration during school closures (10–13), a longitudinal study found a significant decrease in sleep duration among Chinese adolescents (14).

It is also important to note that many adolescents also experienced factors that might increase the risk of short sleep duration during the pandemic, including mental health consequences (15–17), family financial insecurities (18), and child abuse and neglect (18). However, to date, little is known about the protective factors contributing to adolescent sleep duration on a personal level during the pandemic.

The cumulative COVID-19 cases and deaths in USA surged from 20,271,441 and 362,570 on January 3, 2021 to 85,970,435 and 1,007,412 on June 26, 2021, respectively, according to the World Health Organization COVID-19 dashboard data.[1] To better understand the impact of COVID-19 on adolescent sleep duration and identify major protective factors, we used the Adolescent Behaviors and Experiences Survey (ABES) data during January–June 2021 to examine the prevalence of sufficient sleep and associated risk and protective factors among U.S. high school students. The findings in this study suggest developing programs that can increase the sleep duration of all students during and after the pandemic. We, based on existing literature, hypothesized that adolescents identified as heterosexual, without mental health conditions or adverse experiences exposure were more likely to reported eight or more hours of sleep per night.

Materials and methods

Study design and participants

This study includes data from the ABES, a one-time, representative online survey of U.S. high school students conducted by the U.S. Centers for Disease Control and Prevention (CDC) from January–June 2021 to assess student experiences during the COVID-19 pandemic. ABES employed a stratified, three-stage cluster sample to obtain the U.S. nationally representative sample of high school students in grades 9–12. There were 7,705 students from 128 participating schools. Participation in ABES was voluntary, and parental permission was granted. In ABES, the response rate was 38% at the school level, and 48% at the student level, resulting in an overall response rate of 18% (19). This study used pre-existing de-identified and publicly available data; hence no further ethical approval was required. All data used in this study are available at https://www.cdc.gov/healthyyouth/data/abes.htm.

Inclusion and exclusion criteria

All students a selected class in public and private schools with grades 9–12 chosen by ABES sampling frame were eligible for this study. Exclusion criteria included students whose parental permission was not granted, who did not agree to participate, and who were unable to complete the questionnaire independently (19).

Measures

ABES was a 110-question survey, included 97 items from the 2021 national the national Youth Risk Behavior Survey (YRBS) questionnaire, 12 new items assessing COVID-19–related behaviors and experiences and one new question on perceived racism (19).

The primary outcome in this study is sufficient sleep. ABES measured the sleep time using a single item (19): "On an average school night, how many hours of sleep do you get?" with options 1 = 4 or less hours, 2 = 5 h, 3 = 6 h, 4 = 7 h, 5 = 8 h, 6 = 9 h, 7 = 10 or more hours. We identified sufficient sleep as self-reported eight or more hours of sleep on an average school night, according to the recommendation from the American Academy of Sleep Medicine (20).

This study also included other measures in ABES: (1) demographic characteristics, (2) mental health conditions, and (3) student experiences. Demographic variables included sex, grade, sexual identity, and school instructional model. Mental health variables included virtual connection with others, poor mental health during the pandemic, poor mental health during the past 30 days, persistent feelings of sadness or hopelessness during the past 12 months, serious consideration of attempting suicide during the past year, attempted suicide during the past year, feeling close to persons at school and being virtually connected to others during the pandemic (15). And student experiences variables during the COVID-19 pandemic included parental economic, food and nutrition, abuse by a parent or other adult in the home, and difficulty completing schoolwork (18). The ABES questionnaire items and analytic coding used in this study can be found in Table 1.

Statistical analysis

We conducted all analyses using Stata/SE (version 15.1; StataCorp LLC) to account for the complex survey design of the ABES, including primary sampling units, sampling strata, and overall analysis weight (19). We first estimated weighted prevalence and 95% confidence intervals (CIs) of sufficient sleep using Taylor series linearization by

1 https://data.who.int/dashboards/covid19

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TABLE 1 Variables, questionnaire items, and analytic coding.

Variable	Questionnaire item	Analytic coding
Outcome		
Sufficient sleep	On an average school night, how many hours of sleep do you get?	Yes (≥8 h) versus no (<8 h)
Demographic variable		
Sex	What is your sex?	Female versus male
Grade	In what grade are you?	9th, 10th, 11th, 12th
Sexual identity	Which of the following best describes you?	Heterosexual, gay/lesbian/bisexual, other/questioning
Mental health condition		
Poor mental health during the pandemic	During the COVID-19 pandemic, how often was your mental health not good? (Poor mental health includes stress, anxiety, and depression)	Yes (always or most of the time) versus no (never, rarely, or sometimes)
Poor mental health during the past 30 days	During the past 30 days, how often was your mental health not good? (Poor mental health includes stress, anxiety, and depression)	Yes (always or most of the time) versus no (never, rarely, or sometimes)
Persistent feelings of sadness or hopelessness	During the past 12 months, did you ever feel so sad or hopeless almost every day for 2 weeks or more in a row that you stopped doing some usual activities?	Yes versus no
Seriously considered attempting suicide	During the past 12 months, did you ever seriously consider attempting suicide?	Yes versus no
Attempted suicide	During the past 12 months, how many times did you actually attempt suicide?	≥1 time versus 0 times
Felt close to persons at school	Do you agree or disagree that you feel close to people at your school?	Strongly agree or agree versus not sure, disagree, or strongly disagree
Student experience during the pandemic		
Parental job loss	During the COVID-19 pandemic, did a parent or other adult in your home lose their job even for a short amount of time?	Yes versus no
Food and nutrition insecurity	During the COVID-19 pandemic, how often did you go hungry because there was not enough food in your home?	Yes (rarely, sometimes, most of the time, or always) versus no (never)
Emotional abuse by a parent	During the COVID-19 pandemic, how often did a parent or other adult in your home swear at you, insult you, or put you down?	Yes (rarely, sometimes, most of the time, or always) versus no (never)
Physical abuse by a parent	During the COVID-19 pandemic, how often did a parent or other adult in your home hit, beat, kick, or physically hurt you in any way?	Yes (rarely, sometimes, most of the time, or always) versus no (never)
Schoolwork difficulty	Do you agree or disagree that doing your schoolwork was more difficult during the COVID-19 pandemic than before the pandemic started?	Yes (strongly agree, or agree) versus no (not sure, disagree, or strongly disagree)
Virtually connected to others	During the COVID-19 pandemic, how often were you able to spend time with family, friends, or other groups, such as clubs or religious groups, by using a computer, phone, or other device? (Do not count attending school online)	Yes (sometimes, most of the time, always) versus no (never or rarely)

demographic characteristics, mental health conditions, and selected student experiences. Next, we used Chi-square tests to examine the bivariate associations of sufficient sleep with other measures. Furthermore, we adopted multivariate logistic regression to investigate the contributing factors of sufficient sleep after controlling the covariates listed in Table 2, and reported the adjusted odds ratios (AORs) and 95% confidence intervals (CIs). Statistical tests were considered to be significant if two-tailed $p < 0.05$. Complete case analyses were used.

Results

The weighted percentage of students in the sample was 50.4% (95%CI, 46.9–53.9%) female and 49.6% (46.1–53.1%) male. Grade levels were 26.7% (95%CI, 24.0–29.6%) in 9th grade, 25.5% (23.1–28.0%) in 10th grade, 24.3% (2.23–26.4%) in 11th grade, and 23.6% (21.2–26.1%) in 12th grade. For sexual identity, 77.5% (95%CI, 75.6–79.4%) of students identified as heterosexual, 13.2% (11.9–14.6%) identified as gay, lesbian, or bisexual, 9.3% (8.3–10.4%) identified as other or questioning. There were 23.5% (95%CI, 21.6–25.7%) of high school students who reported getting sufficient sleep on an average school night (Table 2).

In univariate analyses (Table 3), male students reported a higher prevalence of sufficient sleep than female students (25.7% versus 21.7%). The prevalence of sufficient sleep was higher among younger students (grade 9, 28.0%; grade 12, 18.1%). Sufficient sleep was more prevalent in heterosexual students (25.3%) than in gay/lesbian/bisexual (14.2%) and other/questioning (17.8%) students (Table 3). However, the prevalence of sufficient sleep ranged from 22.2 to 27.3% in the 3 instructional models of school, and there was a non-significant difference in the prevalence across the 3 models ($p = 0.096$).

The prevalence of sufficient sleep varied by mental health conditions (Table 3). For example, sufficient sleep was more prevalent among students without poor mental health during the pandemic

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TABLE 2 Student characteristics in adolescent behaviors and experiences survey.

Variable	Unweighted N	%† (95% CI)
Sufficient sleep		
Yes	1,644	23.5 (21.6–25.7)
No	5,430	76.5 (74.3–78.4)
Demographic variable		
Sex		
Female	3,999	50.4 (46.9–53.9)
Male	3,678	49.6 (46.1–53.1)
Grade		
9	2,144	26.7 (24.0–29.6)
10	1,949	25.5 (23.1–28.0)
11	1,858	24.3 (2.23–26.4)
12	1,731	23.6 (21.2–26.1)
Sexual identity		
Heterosexual	5,539	77.5 (75.6–79.4)
Gay, lesbian, or bisexual	977	13.2 (11.9–14.6)
Other or questioning	648	9.3 (8.3–10.4)
Mental health condition		
Poor mental health during the pandemic		
Yes (always or most of the time)	2,643	37.1 (34.6–39.6)
No (never, rarely, or sometimes)	4,564	62.9 (60.4–65.4)
Poor mental health during the past 30 days		
Yes (always or most of the time)	2,165	31.1 (28.5–33.7)
No (never, rarely, or sometimes)	4,880	68.9 (66.3–71.5)
Persistent feelings of sadness or hopelessness		
Yes	3,359	44.2 (41.6–46.8)
No	4,303	55.8 (53.2–58.4)
Seriously considered attempting suicide		
Yes	1,538	19.9 (18.0–22.0)
No	6,090	80.1 (78.0–82.0)
Attempted suicide		
Yes (≥1 time)	628	9.0 (7.7–10.5)
No (0 times)	6,110	91.0 (89.5–92.3)
Felt close to persons at school		
Yes	3,279	46.6 (44.1–49.2)
No	3,767	53.4 (50.8–55.9)
Student experience during the pandemic		
Parental job loss		
Yes	1,922	28.5 (26.2–30.9)
No	4,963	71.5 (69.1–73.8)
Food and nutrition insecurity		
Yes (rarely, sometimes, most of the time, or always)	1,698	23.8 (21.6–26.3)
No (never)	5,483	76.2 (73.7–78.4)
Emotional abuse by a parent		
Yes (rarely, sometimes, most of the time, or always)	3,957	55.1 (52.3–57.8)
No (never)	3,176	44.9 (42.2–47.7)
Physical abuse by a parent		
Yes (rarely, sometimes, most of the time, or always)	876	11.3 (10.2–12.4)
No (never)	6,264	88.7 (87.6–89.8)
Schoolwork difficulty		
Yes (strongly agree, or agree)	4,826	66.6 (64.5–68.6)
No (not sure, disagree, or strongly disagree)	2,345	33.4 (31.4–35.5)
Virtually connected to others		
Yes (always, most of the time, or sometimes)	5,005	71.8 (70.2–73.3)
No (never or rarely)	2,080	28.2 (26.7–29.8)

CI, confidence interval. † Estimates are weighted.

(28.4% versus 15.5%, $p < 0.001$) or during the past 30 days (28.4% versus 15.5%, $p < 0.001$), those without persistent feelings of sadness or hopelessness (29.7% versus 15.9%, $p < 0.001$), and those without suicidal ideation (26.1% versus 13.9%, $p < 0.001$) or attempts (24.2% versus 12.4%, $p < 0.001$). In addition, students who felt close to persons at school reported a higher prevalence of sufficient sleep than those who did not feel close to persons at school (25.9% versus 21.4%, $p = 0.001$).

Sufficient sleep differed by adverse experiences during the pandemic (Table 3). The prevalence of sufficient sleep was higher among students who did not experience parental job loss (24.3% versus 20.9%) or food and nutrition insecurity (25.9% versus 15.9%). Sufficient sleep was also more prevalent among students who were never abused by a parent emotionally (30.7% versus 17.8%) or physically (24.5% versus 15.9%). In addition, students who did not have difficulty completing their schoolwork reported a higher prevalence of sufficient sleep than those who reported difficulty completing their schoolwork (28.9% versus 20.9%). However, students who reported virtually connected to others had a similar prevalence of sufficient sleep to those who never or rarely connected to others (24.2% versus 21.6%, $p = 0.087$). Multivariate analyses showed that younger age (AOR, 2.04; 95%CI, 1.59–2.62) and heterosexual identity (AOR, 1.61; 95%CI, 1.19–2.18) were among demographic characteristics associated with sufficient sleep. Among mental health conditions, no poor mental health during the past 30 days (AOR, 1.37; 95%CI, 1.03–1.82) and no persistent feelings of sadness or hopelessness (AOR, 1.34; 95%CI, 1.09–1.66) were associated with sufficient sleep. Among student experiences during the pandemic, no food and nutrition insecurity (AOR, 1.47; 95%CI, 1.17–1.85), never been abused by a parent emotionally (AOR, 1.38; 95%CI, 1.16–1.64), and having no difficulty completing schoolwork (AOR, 1.24; 95%CI, 1.01–1.51) were associated with sufficient sleep (Table 4).

Discussion

In this study, based on a nationally representative American adolescent sample from ABES, we provided evidence of the prevalence

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TABLE 3 Percentage of sufficient sleep by selected demographic characteristics, mental health conditions and student experiences.

Variable	%[†] (95% CI)	*p* value[§]
Demographic characteristics		
Sex		
Female	21.7 (19.5–24.2)	0.009
Male	25.7 (23.1–28.5)	
Grade		
9	28.0 (24.9–31.3)	<0.001***
10	25.8 (22.5–29.4)	
11	21.8 (18.8–25.1)	
12	18.1 (15.1–21.5)	
Sexual identity		
Heterosexual	25.3 (23.0–27.8)	<0.001***
Gay, lesbian, or bisexual	14.2 (11.2–17.9)	
Other or questioning	17.8 (14.8–21.3)	
Instructional model of school		
In-person only	26.6 (18.4–36.8)	0.096
Virtual only	27.3 (22.1–33.1)	
Hybrid	22.2 (20.5–24.1)	
Mental health condition		
Poor mental health during the pandemic		
Yes (always or most of the time)	15.5 (13.6–17.5)	<0.001***
No (never, rarely, or sometimes)	28.4 (25.7–31.2)	
Poor mental health during the past 30 days		
Yes (always or most of the time)	15.5 (13.6–17.5)	<0.001***
No (never, rarely, or sometimes)	28.4 (25.7–31.2)	
Persistent feelings of sadness or hopelessness		
Yes	15.9 (14.3–17.7)	<0.001***
No	29.7 (26.9–32.7)	
Seriously considered attempting suicide		
Yes	13.9 (11.8–16.2)	<0.001***
No	26.1 (23.8–28.4)	
Attempted suicide		
Yes (≥1 time)	12.4 (9.3–16.3)	<0.001***
No (0 times)	24.2 (22.1–26.5)	
Felt close to persons at school		
Yes (Strongly agree or agree)	25.9 (23.3–28.7)	0.001**
No (Not sure, disagree, or strongly disagree)	21.4 (19.2–23.7)	
Student experience during the pandemic		
Parental job loss		
Yes	20.9 (17.9–24.2)	0.039*
No	24.3 (22.1–26.5)	
Food and nutrition insecurity		
Yes (rarely, sometimes, most of the time, or always)	15.9 (13.8–18.2)	<0.001***
No (never)	25.9 (23.6–28.3)	
Emotional abuse by a parent		
Yes (rarely, sometimes, most of the time, or always)	17.8 (15.9–19.8)	<0.001***
No (never)	30.7 (27.8–33.7)	
Physical abuse by a parent		
Yes (rarely, sometimes, most of the time, or always)	15.9 (12.5–19.9)	<0.001***
No (never)	24.5 (22.3–26.8)	
Schoolwork difficulty		
Yes (strongly agree, or agree)	20.9 (18.8–23.2)	<0.001***
No (not sure, disagree, or strongly disagree)	28.9 (25.9–32.1)	
Virtually connected to others		
Yes (always, most of the time, or sometimes)	24.2 (21.9–26.7)	0.087
No (never or rarely)	21.6 (19.1–24.3)	

CI, confidence interval; NA, not applicable.

[†] Estimates are weighted. [§] Chi-square test. *$p < 0.05$, **$p < 0.01$, *** $p < 0.001$.

of sufficient sleep and its contributing factors among high school students during the COVID-19 pandemic. We found only a quarter of high school students reported getting the recommended amount of sleep. We detected that younger students, students identified as heterosexual, and without certain mental health conditions or adverse experiences are more likely to report at higher likelihood of sufficient sleep, providing hints for further interventions in the response to a possible future pandemic caused by Disease X.

Insufficient sleep remained widespread during the COVID-19 pandemic, affecting 76.5% of students in USA (21) and 75.41% of students in Shandong, China (22). Similarly, in our study nearly only a quarter of high school students achieved recommended amounts of sleep on an average school night.

This study provides the first evidence for the effect of instructional models on sleep duration among adolescents during the pandemic. During the COVID-19 pandemic, although different instructional models (i.e., in-person only, virtual only, and hybrid) were used across the United States, the students reported a similar prevalence of sufficient sleep.

Before and during the COVID-19 pandemic, sexual minority (23, 24) is linked to sufficient sleep. Consistent with existing studies (10, 23, 24), we found that heterosexual students reported a higher prevalence of sufficient sleep, which indicated that policies need to address the discrimination and challenge social norms for adolescent sexual minority.

Older adolescents tend to report insufficient sleep due to academic pressure before the COVID-19 pandemic (25). Exiting studies suggested that younger children were associated with a higher risk of insufficient sleep during the COVID-19 pandemic duo to lacking of understanding of the COVID-19 (26). In a senior high school sample, we found an association of older age and insufficient sleep, which is partly caused by longer electronic media use and higher academic pressure among older adolescents.

TABLE 4 Associations of sufficient sleep with contributing factors.

Variable	AOR† (95% CI)	*p* value§
Demographic characteristic		
Sex (Ref: female)		
Male	0.89 (0.73–1.09)	0.258
Grade (Ref: grade 12)		
9	2.04 (1.59–2.62)	<0.001***
10	1.68 (1.30–2.17)	<0.001***
11	1.43 (1.07–1.92)	0.016*
Sexual identity (Ref: gay, lesbian, or bisexual)		
Heterosexual	1.61 (1.19–2.18)	0.002*
Other or questioning	1.23 (0.78–1.94)	0.368
Instructional model of school (Ref: In-person only)		0.096
Virtual only	0.91 (0.43–1.92)	0.800
Hybrid	0.71 (0.35–1.46)	0.343
Mental health condition		
Poor mental health during the pandemic (Ref: Yes)		
No	1.16 (0.90–1.50)	0.245
Poor mental health during the past 30 days (Ref: Yes)		
No	1.37 (1.03–1.82)	0.031*
Persistent feelings of sadness or hopelessness (Ref: Yes)		
No	1.34 (1.09–1.66)	0.006*
Seriously considered attempting suicide (Ref: Yes)		
No	1.13 (0.86–1.48)	0.388
Attempted suicide (Ref: Yes)		
No	1.00 (0.61–1.64)	0.985
Felt close to persons at school (Ref: Yes)		
No	0.94 (0.80–1.12)	0.506
Student experience during the pandemic		
Parental job loss (Ref: Yes)		
No	1.06 (0.85–1.33)	0.584
Food and nutrition insecurity (Ref: Yes)		
No	1.47 (1.17–1.85)	0.001*
Emotional abuse by a parent (Ref: Yes)		
No	1.38 (1.16–1.64)	<0.001***
Physical abuse by a parent (Ref: Yes)		
No	1.18 (0.85–1.65)	0.323
Schoolwork difficulty (Ref: Yes)		
No	1.24 (1.01–1.51)	0.036*
Virtually connected to others (Ref: Yes)		
No	1.03 (0.83–1.29)	0.753

Ref, reference group; AOR, adjusted odds ratio (adjusted for other variables).
† Estimates are weighted. § Multivariate logistic regression. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

Before and during the COVID-19 pandemic, adolescent mental health issues remain an international public health concern. Before the COVID-19 pandemic, one study based on YRBS 2017 indicated that adolescent insufficient sleep was associated with suicidal ideation (AOR = 1.35, 95% CI = 1.16–1.58). Another review article revealed the links between adolescent insufficient sleep and depression (27). During the COVID-19 pandemic, in line with the results of other study (28), we identified two mental health conditions measured in ABES that were associated with a higher risk of insufficient sleep among U.S. high school students. More concretely, students with poor mental health during the past 30 days and persistent feelings of sadness or hopelessness both reported a higher risk of insufficient sleep. Considering the potential mental health consequences of the ongoing pandemic for adolescents (29), our findings underscore the particular need to address adolescent mental health needs in the context of sufficient sleep. Although one longitudinal survey in Chinese college students (30) suggested that insufficient sleep predicts the development and persistence of suicidal ideation during the initial COVID-19 outbreak (February 3rd to 10th, 2020) and the remission period (March 24th to April 3rd, 2020), we did not observe this association in ABES. The inconsistent results might be multifactorial, including differences in research sample and government response.

During the COVID-19 pandemic, changes also occurred on the family level, including financial difficulty, food insecurity, and domestic abuse (31). Adolescent positive experiences were associated with sufficient sleep among U.S. high school students. More concretely, students without food and nutrition insecurity, emotional abuse, or schoolwork difficulty reported a higher likelihood of sufficient sleep. The COVID-19 pandemic related stress contributes to domestic violence in the context of students' decreased contact with mandated reporters because of school closures (32). Financial and food insecurities induced by COVID-19 are linked to increased child abuse (32). The findings highlight the need for enhanced violence intervention strategies. In addition, schoolwork difficulty was associated with a higher risk of insufficient sleep but virtually connected to others was not. Compared with before the pandemic, students with insufficient sleep were more likely to report greater difficulty doing schoolwork during the pandemic (21). In line with previous study (33), our findings highlighted the important of virtually connected to others in extending sleep duration. At last, these experiences that contribute to insufficient sleep are interconnected (34), and a multi-level intervention approach to sufficient sleep is needed. The education authority and government policy-makers could frame and implement guidelines to improve sleep to augment mental health conditions and experiences in next pandemics.

Limitations

The study has three specific limitations in addition to the general limitations for the ABES (e.g., including cross-sectional design, representativeness, social desirability bias, and low response rates) (19). First, the outcome was measured by asking about the sleep duration on an average school night. However, the COVID-19 pandemic has been sweeping across the United States and the world; hence the question can be understood within the context of the pandemic. Second, more robust measurements for both sleep duration (e.g., actigraphy) and contributors (e.g.,

assessment scales) are need. ABES adopt items from YRBS and measured sleep, mental health and experience by single questions, although YRBS items demonstrated good validity in measuring sleep duration (35) and suicidal ideation and attempts (36). Third, ABES did not measure sleep disturbances (e.g., snoring and insomnia) and sleep quality that largely influence the sleep duration. Last, ABES did not ask students about the period of instructional models in the schools they are attending, which might influence the findings.

Conclusion

Sleep duration is a significant public health concern during the ongoing COVID-19 pandemic. The findings in this study indicate that in addition to sexual minority students, students with mental health conditions with adverse experiences during the pandemic are at higher risk of insufficient sleep. Therefore, comprehensive strategies are needed to improve sleep duration among adolescents in future pandemics.

Data availability statement

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

Ethics statement

Ethical approval was not required for the study involving humans in accordance with the local legislation and institutional requirements. Written informed consent to participate in this study was not required from the participants or the participants' legal guardians/next of kin in accordance with the national legislation and the institutional requirements.

Author contributions

ZC: Data curation, Funding acquisition, Writing – original draft, Writing – review & editing. RL: Formal analysis, Methodology, Project administration, Resources, Writing – review & editing. YL: Project administration, Validation, Writing – review & editing. QL: Conceptualization, Writing – original draft, Writing – review & editing.

Funding

The author(s) declare financial support was received for the research, authorship, and/or publication of this article. This study was supported by the New Capital Institute of Pediatrics Innovation Transformation Project (CX-2022-05).

Acknowledgments

The authors would like to appreciate U.S. Centers for Disease Control and Prevention for the efforts on data sharing of ABES.

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

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frontiers | Frontiers in Public Health

TYPE Original Research
PUBLISHED 23 August 2024
DOI 10.3389/fpubh.2024.1392845

OPEN ACCESS

EDITED BY
Yuka Kotozaki,
Iwate Medical University, Japan

REVIEWED BY
Roel Van Overmeire,
Vrije University Brussels, Belgium
Parandis Pourdehghan,
Tehran University of Medical Sciences, Iran

*CORRESPONDENCE
Wai Kai Hou
✉ wkhou@eduhk.hk

†These authors share first authorship

RECEIVED 28 February 2024
ACCEPTED 18 July 2024
PUBLISHED 23 August 2024

CITATION
Li CJ, Zheng Y, Gan Y, Du Z, Cai X, Li Y, Wang W, Jiang T, Zhang Q, Niu L, Tao TJ and Hou WK (2024) Mental health of primary health care physicians and nurses following prolonged infection control rules: a national survey in China.
Front. Public Health 12:1392845.
doi: 10.3389/fpubh.2024.1392845

Mental health of primary health care physicians and nurses following prolonged infection control rules: a national survey in China

Crystal Jingru Li[1†], Yanling Zheng[2†], Yong Gan[3], Zhaohui Du[4], Xuemin Cai[5], Yongjin Li[6], Wei Wang[7], Tianwu Jiang[8], Qingyu Zhang[9], Lei Niu[10], Tiffany Junchen Tao[1] and Wai Kai Hou[1,11*]

[1]Centre for Psychosocial Health, The Education University of Hong Kong, Hong Kong, Hong Kong SAR, China, [2]Shouyilu Street Community Health Service Center, Wuhan, Hubei, China, [3]Department of Social Medicine and Health Management, School of Public Health, Tongji Medical College, Huazhong University of Science and Technology, Wuhan, Hubei, China, [4]Department of Administrative Management, Shanggang Community Health Service Center, Shanghai, China, [5]Department of Administrative Management, Laoshan Community Health Service Center, Qingdao, Shandong, China, [6]Department of Administrative Management, Jinsong Community Health Service Center, Beijing, China, [7]Department of Administrative Management, Xinhua Shaocheng Community Health Service Center, Chengdu, Sichuan, China, [8]Department of Administrative Management, Tianshui Wulin Street Community Health Service Center, Hangzhou, Zhejiang, China, [9]Department of Administrative Management, Jiexin Village Community Health Service Center, Lanzhou, Gansu, China, [10]Department of Administrative Management, Xinglin Street Community Health Service Center, Hefei, Anhui, China, [11]Department of Psychology, The Education University of Hong Kong, Hong Kong, Hong Kong SAR, China

Introduction: This study examined the prevalence and correlates of probable mental health disorders, including psychological distress, somatization, depression, anxiety, phobic anxiety (PHO), obsessive-compulsive disorder (OCD), post-traumatic stress disorder (PTSD), and insomnia among Chinese primary health care (PHC) physicians and nurses amid the post-pandemic period in 2022.

Method: Region-stratified sampling was conducted to recruit a national sample of 4,246 respondents from 31 July 2022 to 12 August 2022. A total of 692 primary healthcare institutions were identified in 30 provincial-level administrative regions of China. An online questionnaire was used for assessing probable mental health disorders using Symptoms Checklist-90-Revised (SCL-90-R) and PTSD Checklist for DSM-5 (PCL-5), and sleeping problems using Insomnia Severity Index (ISI). Data on demographics and work were also collected. Bivariate analysis and multiple logistic regression were conducted to identify significant correlates of probable mental health disorders.

Results: A total of 4,246 valid questionnaires were identified. Results showed that relative to the prevalence of probable mental health disorders among health care workers at the early stage of the pandemic in China, there was an overall decreased prevalence except for somatization, PHO, and OCD among the current PHC physicians and nurses. Multiple logistic regressions showed that significant risk factors of common probable mental health disorders, namely psychological distress, SOM, DEP, ANX, PHO, OCD, PTSD, and insomnia, were female gender, multimorbidity, history of psychiatric disorders, quarantine experience, never asking anyone for help, and overtime work.

Conclusion: Attention should be given to preexisting psychiatric and multimorbid conditions, social support, and work-related stressors. Regular assessment and psychological interventions are needed to enhance the mental health of PHC professionals even after public health crisis.

KEYWORDS

COVID-19, mental health disorder, primary healthcare physician and nurse, post-pandemic, SCL-90-R, post-traumatic stress disorder, insomnia

1 Introduction

Starting from the lockdown of Wuhan on January 23rd, 2020, China adopted some of the most prolonged and stringent infection control policies compared with other countries, including widespread regional lockdown, large-scale quarantine, mass temperature screening, community closed management, and extensive public health education in the community (1). China further implemented a dynamic zero-COVID policy to minimize COVID-19 transmission starting August 2021 until the abrupt lifting of all infection control rules on 26th December, 2022 (2). The outbreak of the COVID-19 pandemic has brought a substantial and prolonged crisis across the globe, characterized by high infection risk and death rates and could be defined as a traumatic event to all affected people especially those who have either been infected or have suffered from serious medical conditions due to the pandemic, including primary health care (PHC) workers (3–5). The prolonged infection control created significant challenges for Chinese PHC physicians and nurses. Different from the medical professionals at secondary and tertiary hospitals in China, PHC physicians and nurses were the important cornerstone of the healthcare system and the first point of contact for individuals and families in the community, who have taken up the key role of implementing the infection control rules such as diagnosis, triage, and monitoring in collaboration with hospitals and the health department (6–8). Prolonged infection control has been found to create extra challenges to PHC physicians and nurses (6, 9), including overtime work (working hours $\geq$50 h per week) (10), night duty number $\geq$10 (11), long shift workhours (8–12 h) (12), working in high-risk environment (e.g., working front-line, working in hardest hit area, or providing direct care to infected patients) (6), and providing direct care to infected patients in ICU or Fangcang shelter hospitals (13, 14).

During the pandemic, frontline healthcare workers could experience continued physical and psychological distress due to prolonged control rules and challenges in multiple stressful and high-risk work environments (6, 11, 15–22). Initial evidence has been gathered upon high probable mental health disorders among Chinese PHC physicians and nurses (5, 23, 24), consistent with the high prevalence of probable mental health disorders across different stages of the pandemic among Chinese medical workers (4). It remains unclear whether the high prevalence was consistent across regions, urban and rural settings, and demographic and occupational characteristics (8, 25). Such evidence will be of global relevance for optimizing the resilience of the primary care system for any future pandemic or large-scale disasters (26, 27).

Previous studies in other regions have identified sociodemographic factors of mental health disorders including younger age, female gender, being unmarried, having children or dependents to care, preexisting chronic disease(s), and histories of psychiatric disorders (13, 15, 20, 21, 27, 30, 31). Apart from demographics, risk factors could be significant risk factors of mental health disorders. Among healthcare professionals in Canada, other health care workers relative to physicians have been found to report higher levels of symptoms of depression, anxiety, and perceived (28). Specifically, nurses have been consistently found to be more vulnerable to psychological problems than physicians across regions (6, 14, 23, 29). Technical and administrative staff have been demonstrated to experience higher odds of common mental disorders, including depression, anxiety disorders, post-traumatic stress disorder, panic attacks, and substance use disorder (13). In addition, redeployment, lack of specialized training, and insufficient relevant medical work experience were found to be associated with higher symptoms of anxiety, burnout, depression, and PTSD (15, 18, 21).

The current study aims to investigate the prevalence of probable mental health disorders, including, somatization, depression, anxiety, phobic anxiety, obsessive-compulsive disorder, PTSD, and insomnia and their sociodemographic and occupational correlates among a national sample of PHC physicians and nurses amid the post-pandemic era in China. This study hypothesizes that probable mental health disorders are more common among PHC physicians and nurses in regions with a more significant impact of the pandemic and concomitant infection control (15, 32) and the prevalence of probable mental disorders are positively associated with sociodemographic and work-related risk factors.

2 Materials and methods

2.1 Study design and respondents

Upon obtaining the ethics committee's approval from The 7th Hospital of Wuhan (220701), respondents were recruited using region-stratified sampling. The sampling regions are shown in Figure 1. Five geographical regions of China were covered, including the central (3 provinces), southeast (7 provinces, 1

Abbreviations: PHC, Primary health care; SOM, Somatization; OCD, Obsessive-compulsive disorder; DEP, Depression; ANX, Anxiety; PHO, Phobic anxiety; PTSD, Post-traumatic stress disorder.

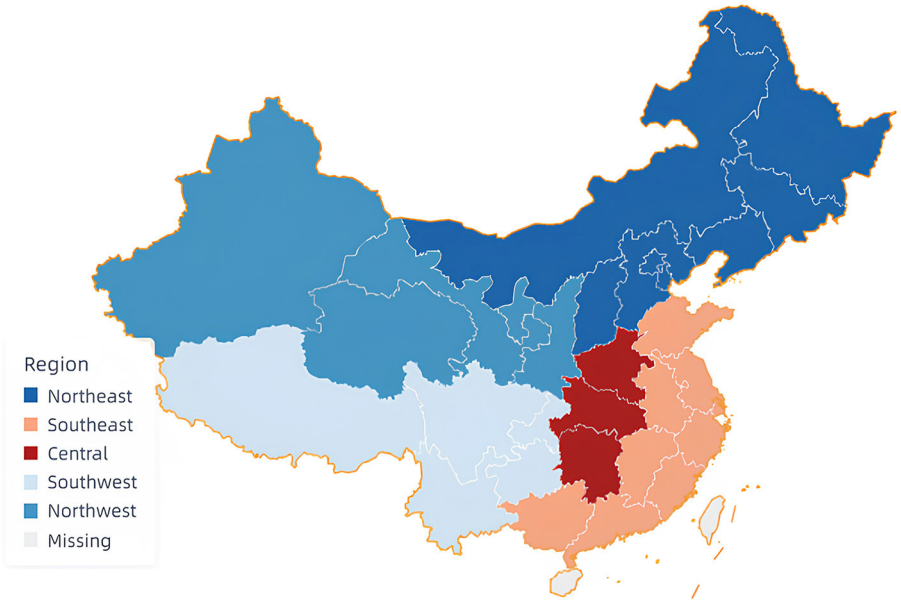

FIGURE 1
The five regions of China participated in the current study.

autonomous region, 1 municipality), southwest (3 provinces, 1 autonomous region, 1 municipality), northeast (5 provinces, 1 autonomous region, 2 municipalities), and northwest (3 provinces, 2 autonomous regions) (33). A total of 30 administrative regions (21 provinces, 5 autonomous regions, 4 municipalities) were covered.

Recruitment of respondents and administration of the survey was conducted online via Wenjuanxing, a widely used platform in China, from July 31-August 12, 2022. Electronic questionnaires were delivered through the Community Health Center Directors' Alliance affiliated with the Community Health Association of China, which is a national first-level organization under the management of the Ministry of Civil Affairs and the National Health Commission. Inclusion criteria were (1) age 18 years or above and (2) PHC physicians and nurses. Respondents were randomly selected using a disproportionate stratified sampling design with nine strata defined according to gender (male and female), occupation (physician and nurse), and technician title (none, junior, intermediate, associate senior, and senior). To ensure that the current sample was representative of PHC physicians and nurses in China (34), the current study (1) oversampled female respondents, (2) recruited physicians and nurses in the ratio of approximately 1:1, and (3) recruited respondents with junior and intermediate technician title based on the proportion of healthcare professionals as outlined in previous PHC national sample in China (35). Electronic informed consent was obtained from all respondents before the survey. All questions in the questionnaire needed to be answered before submission resulting in the absence of missing data. A returned survey was considered invalid if (1) no electronic informed consent, (2) the average response time on each item was <2 s (34), or (3) maximum long string (i.e., consecutive identical responses) was equal to or larger than half of the item number (35, 36).

2.2 Measurements

2.2.1 Background variables

Demographic data were collected, including gender, age, province, residence (rural or urban), workplace (i.e., community health center or station, village and township clinics), education level (i.e., below bachelor, bachelor, and master or above), marital status (i.e., unmarried and married), childcare responsibility (yes or no, age of the child is required to be indicated), and any diagnosed chronic medical conditions (i.e., no, hypertension, diabetes, chronic obstructive pulmonary disease, pneumonia, chronic bronchitis, stroke, and others). They also reported their occupation (i.e., doctor, nurse), technical title (i.e., none, junior, intermediate, associate senior, and senior), and frequency of overtime/longer than 8 hours of work (not at all, sometimes, more than half the time, and almost every day). Respondents also rated fear of infecting COVID-19 on duties (strongly disagree, disagree, neutral, agree, strongly agree) and the cumulative number of quarantines (0, 1, 2, 3, or more than 3).

2.2.2 Probable mental health disorders

Probable mental health disorders were measured using the Chinese version of Symptoms Checklist-90-Revised (SCL-90-R) (37), the 20-item PTSD Checklist for DSM-5 (PCL-5) (38), and the 7-item Insomnia Severity Index (ISI) (39).

2.2.2.1 SCL-90-R

Respondents rated on a 5-point scale (0 = not at all, 1 = a little bit, 2 = moderately, 3 = quite a bit, 4 = extremely) for nine dimensions of psychological distress, including somatization (SOM), obsessive-compulsive disorder (OCD), interpersonal sensitivity, depression (DEP), anxiety (ANX),

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TABLE 1 Sociodemographic characteristics of PHC physicians and nurses.

Variables	*n* (%)	
Sex		
Male	817	(19.2)
Female	3,429	(80.8)
Age [Mean (SD)]	37.84	(9.24)
18–34	1,715	(28.8)
35–49	1,960	(41.2)
50 or above	571	(53.3)
Marital status		
Unmarried	787	(18.5)
Married	3,459	(81.5)
Living region		
Central	1,462	(34.4)
Southeast	1,427	(33.6)
Southwest	646	(15.2)
Northeast	327	(7.7)
Northwest	384	(9.0)
Living areas		
Urban	3,565	(84.0)
Rural	681	(16.0)
Education		
Below bachelor	1,545	(36.4)
Bachelor or above	2,701	(63.6)
Workplace		
Village and township clinics	671	(15.8)
Community health service center	3,575	(84.2)
Occupation		
Doctor	2,120	(49.9)
Nurse	2,126	(50.1)
Doctor job position		
Not applicable	2,126	(50.1)
Front-line	2,033	(47.9)
Non-front-line	87	(2.0)
Technical title		
None	364	(8.6)
Junior	1,731	(40.8)
Intermediate	1,652	(38.9)
Associated senior	442	(10.4)
Senior	57	(1.3)
Overtime work		
Never	278	(6.5)
Sometimes	2,744	(64.6)
More than half the time	804	(18.9)
Almost everyday	420	(9.9)
Childcare responsibility		
No	1,774	(41.8)
Yes	2,472	(58.2)
Chronic disease		
No	3,301	(77.7)
Yes	945	(22.3)
Multimorbidity		
No	3,927	(92.5)
Yes	319	(7.5)
Psychiatric history		
No	4,161	(98)
Yes	85	(2.0)
Afraid of COVID-19		
No	3,772	(88.8)
Yes	474	(11.2)
Cumulative quarantine times		
0	3,113	(73.3)
1	641	(15.1)
2	259	(6.1)
≥3	233	(5.5)
Emotional support from colleague		
Care to some extent	4,028	(94.9)
Never care about each other	218	(5.1)
Emotional support-seeking behavior		
Tell others	3,783	(88.1)
Never tell anyone	463	(10.9)
Instrumental support-seeking behavior		
Ask others for help	3,794	(89.4)
Never ask anyone for help	452	(10.6)

(Continued)

TABLE 1 (Continued)

SD, standard deviation; PHC, primary health care.

hostility, phobic anxiety (PHO), paranoid ideation, psychoticism, and seven additional items that assess appetite and sleep disturbances. The scores of all 90 items were averaged to form the Global Severity Index (GSI) to indicate overall psychological distress. GSI scores ≥1 indicated probable general psychological distress (37). Average scores were also calculated for SOM, DEP, ANX, PHO, and OCD. Raw average scores were then converted into T-scores (mean = 50, SD = 10) based on the mean scores of prior representative samples of Chinese medical workers (40). Subscale T-scores ≥63 were identified as high psychological distress/probable mental disorders (subscales) (41). SCL-90-R has been found to be valid and reliable for assessing mental health symptoms in Chinese populations (42). In the current study, Cronbach's α of the SCL-90-R = 0.990. The Cronbach's α for the

TABLE 2 Prevalence of current probable mental health disorders among primary health care physicians and nurses.

	PHC physicians and nurses (n = 4,246)	
	n (%)	
Psychological distress	489	(11.5)
Somatization	476	(11.2)
Depression	349	(8.2)
Anxiety	250	(5.9)
Phobic anxiety	263	(6.2)
Obsessive-compulsive disorder	336	(7.9)
Interpersonal sensitivity	288	(6.8)
Hostility	384	(9.0)
Paranoid ideation	262	(6.2)
Psychoticism	297	(7.0)
Post-traumatic stress disorder	292	(6.9)
Insomnia	766	(18.0)
Absence	2,903	(68.4)
Sub-threshold	1,118	(26.3)
Moderate	183	(4.3)
Severe	42	(1.0)

Psychological distress was defined when GSI score ≥1 in SCL-90-R; probable mental health disorders were defined when subscale T-scores ≥63 in SCL-90-R.

selected subscales showed good internal consistency: SOM = 0.929, DEP = 0.942, ANX = 0.935, PHO = 0.898, and OCD = 0.922.

2.2.2.2 PCL-5

Respondents reported their experiences and responses to the threat of traumatic events in the past month on a 5-point scale (0 = not at all, 4 = extremely). A cutoff score of 33 or above was used to indicate probable PTSD (43). PCL-5 has been shown to have excellent internal consistency, test-retest reliability, and convergent and discriminant validity (44). The valid and reliable Chinese version of PCL-5 was widely used across Chinese populations (45). The Cronbach's α was 0.978 in the current administration.

2.2.2.3 ISI

The index assessed the nature, severity, and impact of insomnia on a 5-point scale (0 = none, 1 = mild, 2 = moderate, 3 = severe, and 4 = very severe). A cutoff score of 10 was used to indicate probable insomnia (39). ISI is a valid and reliable instrument for detecting insomnia among Chinese health care workers (6). In the present study, the Cronbach's α = 0.822.

2.2.3 Workplace social support

Social support in the workplace was assessed using selected items from the Social Support Rating Scale (46), including emotional support from colleagues (You and your colleagues: 1 = Never care for each other, just nod to each other, 4 = Most colleagues care about you), seeking emotional support (The way you confide when you have trouble: 1 = Never tell anyone, 4 = Confide your troubles voluntarily to get support and understanding), and seeking instrumental support (The way you seek help when you are in trouble: 1 = Only rely on themselves and do not accept help from others, 4 = Frequently ask for help from family, relatives, and organizations when in trouble). Higher scores indicated higher levels of social support and support-seeking. Social Support Rating Scale has shown good validity and reliability across Chinese populations (26, 47). In the present study, the alpha was 0.788.

2.3 Statistical analysis

First, we examined the prevalence of different probable mental health disorders. Nonparametric Mann-Whitney U tests were conducted to investigate sociodemographic and occupational correlates of mental health disorders. Next, multiple logistic regressions were conducted to test the correlates that were significant in previous bivariate analyses within a multivariable environment. Adjusted odds ratios (aORs) with 95% CI were reported. SPSS 26.0 (RRID:SCR_002865) was used for all analyses.

3 Results

3.1 Respondents and descriptive characteristics

The sampling frame consisted of 692 primary healthcare institutions, with 518 in urban areas and 174 in rural areas. A total of 5,826 online surveys were received, among which 4,246 (72.9%) were identified as valid data. Demographics did not differ between respondents with and without a valid survey (gender: p = 0.565, age: p = 0.046, marital status: p = 0.006, education level: p = 0.423, region: p = 0.037, residence: p = 0.785). The sample (37.8 ± 9.2 years of age) consisted of 2,120 physicians (49.9%) and 2,126 nurses (50.1%), among which 3,429 (80.8%) were female. The gender ratio was consistent with the ratio of 1:3 among Chinese primary medical workers (48). A total of 2,095 (49.3%) were in general practice; 3,575 (84.2%) worked in community health service centers and the remainder (n = 671, 15.8%) in village and township clinics. The majority of the respondents had never been quarantined (n = 3,113, 73.3%) and did not indicate fear of COVID-19 (n = 1,133, 88.9%). More than 60% reported overtime work sometimes (n = 2,744, 64.6%) and about 10% reported overtime work almost every day (n = 420). Demographics and study variables are summarized in Table 1.

3.2 Prevalence of mental health disorders

As shown in Table 2, among the 4,246 respondents, 11.5% of the respondents reported general psychological distress (95%CI = 10.6, 12.5), 11.2% (95%CI = 10.3, 12.2) reported somatization, 8.2% (95%CI = 7.4, 9.1) reported probable depression, 5.9% (95%CI = 5.2, 6.6) reported probable anxiety, 6.2% (95%CI = 5.5, 7.0) reported probable phobic anxiety, 7.9% (95%CI = 7.1, 8.8) reported probable OCD, 6.8% (95%CI = 6.0, 7.6) reported probable interpersonal sensitivity, 9.0% (95%CI = 8.2, 8.9) reported probable hostility, 6.2% (95%CI = 5.5, 6.9) reported probable paranoid

ideation, 7.0% (95%CI = 6.2, 7.7) reported probable psychoticism, 6.9% (95%CI = 6.1, 7.7) reported probable PTSD, and 18% (95%CI = 16.9, 19.2) reported probable insomnia.

3.3 Correlates of probable mental health disorders

The multiple results of the logistic regression analyses are presented in Table 3. Female gender, multimorbidity, psychiatric histories, quarantine experience, working overtime for half of the time or more, and never asking help were associated with increased odds of the following outcomes: probable general psychological distress (aOR = 1.54–7.06, 95%CI = 1.14–4.41, 2.08–11.31), somatization (aOR = 1.86–5.52, 95%CI = 1.37–4.41, 2.52–8.89), depression (aOR = 1.59–8.97, 95%CI = 1.25–5.55, 2.56–14.49), anxiety (aOR = 1.47–9.73, 95%CI = 1.10–5.88, 1.96–16.07), phobic anxiety (aOR = 1.58–6.84, 95%CI = 1.20–4.12, 2.07–11.37), OCD (aOR = 1.50–7.13, 95%CI = 1.17–4.40, 1.92–11.55), PTSD (aOR = 1.48–6.97, 95%CI = 0.99–4.25, 2.21–11.44), and insomnia (aOR = 1.38–5.96, 95%CI = 1.08–3.73, 1.76–9.54). In addition, older age was associated with increased odds of probable somatization (aOR = 1.02, 95%CI = 1.00, 1.03), whereas having a bachelor's degree or above was associated with increased odds of probable general psychological distress (aOR = 1.43, 95%CI = 1.11, 1.82), somatization (aOR = 1.39, 95%CI = 1.08, 1.78), OCD (aOR = 1.39, 95%CI = 1.04, 1.86), interpersonal sensitivity (aOR = 1.25, 95%CI = 1.02, 1.52), psychoticism (aOR = 1.45, 95%CI = 1.12, 1.88), and insomnia (aOR = 1.29, 95%CI = 1.06, 1.57). Relative to respondents living in the Central region, those living and working in the Southeast region were more likely to report probable somatization (aOR = 1.39, 95%CI = 1.08, 1.79), and PTSD (aOR = 1.49, 95%CI = 1.09, 2.04). Those living in the Southwest region were more likely to report probable general psychological distress (aOR = 1.48, 95%CI = 1.10, 2.01), somatization (aOR = 1.52, 95%CI = 1.12, 2.07), hostility (aOR = 1.31, 95%CI = 1.01, 1.70), paranoid ideation, (aOR = 1.43, 95%CI = 1.07, 1.92), psychoticism (aOR = 1.68, 95%CI = 1.21, 2.33), and PTSD (aOR = 1.51, 95%CI = 1.03, 2.21). Respondents with colleagues never caring about each other at work reported increased odds of probable phobic anxiety (aOR = 2.00, 95%CI = 1.30, 3.07), interpersonal sensitivity (aOR = 1.48, 95%CI = 1.05, 2.09), psychoticism (aOR = 1.65, 95%CI = 1.12, 2.42), and PTSD (aOR = 1.72, 95%CI = 1.11, 2.66) relative to respondents with colleagues caring to some extent. Finally, those never confiding their troubles to others reported increased odds of psychological distress (aOR = 1.85, 95%CI = 1.34, 2.56), probable somatization (aOR = 1.73, 95%CI = 1.24, 2.42), depression (aOR = 1.79, 95%CI = 1.24, 2.58), anxiety (aOR = 2.07, 95%CI = 1.37, 3.12), phobic anxiety (aOR = 1.75, 95%CI = 1.17, 2.62), and OCD (aOR = 1.91, 95%CI = 1.32, 2.77). Results from bivariate analyses are summarized in Supplementary material 1.

4 Discussion

This study aims to investigate the prevalence of probable mental health disorders, and identify sociodemographic and work-related risk factors of the prevalence in a national sample of primary health care (PHC) physicians and nurses after a prolonged period of stringent infection control rules in China. The prevalence of probable mental health disorders ranged from 5.9% to 18%. Female gender, multimorbidity, psychiatric histories, and quarantine experience were related to increased odds of common probable mental health disorders, namely SOM, DEP, ANX, PHO, OCD, PTSD, and insomnia. On top of these sociodemographics were work-related factors including frequent working overtime, and never asking for help at work.

4.1 Prevalence of mental health disorders

Two years after the COVID-19 pandemic outbreak, the prevalence of probable depression (8.2%), anxiety (5.9%), PTSD (6.9%), and insomnia (18%) of Chinese PHC physicians and nurses reduced by over 13.8% compared with previous studies in the acute phase (i.e., 8th December 2019–11th March 2020), which reported a pooled prevalence of 31.0% for probable depression, 29.0% for probable anxiety, and 13.2%-75.2% for PTSD among physicians (30) and nurses (49). However, the prevalence of probable phobic anxiety (6.2%) and OCD (7.9%) slightly increased compared to previous studies (5.3–5.5%) (8, 50). Increased probable anxiety and OCD could be attributable to the traumatic experiences and fear of infection. A sense of uncontrollability, has been found to be related to increased anxiety symptoms (52), whereas the increased OCD symptoms could be related to personal hygiene and protection measures (6, 51). Our findings further suggested that this sense of uncontrollability might persist or heighten even after the traumatic event. PHC physicians and nurses might practice repetitive personal hygiene measures as compulsions to protect from infection or alleviate distress (6). Moreover, PHC physicians and nurses could be exposed to high levels of suffering and death, leading to heightened phobic anxiety (53). It is important to note that the prevalence of probable somatization (11.2%) was higher than that at the early stage of COVID-19 (5.3%) (8). Our findings suggested that somatization symptoms could be one of the most serious mental health disorders in Chinese PHC physicians and nurses during the post-pandemic period, with stress and distress expressed through physical symptoms probably resulting from prior increased workload and demands, exposure to traumatic events, or personal or family stressors related to the pandemic (54).

4.2 Risk factors of probable mental health disorders

4.2.1 Sociodemographics

In line with previous studies (4, 15), the current study similarly found that female gender was a risk factor for different mental health disorders. Adding to the mixed previous evidence on age (8, 15), our study found that older age was associated with higher odds of probable somatization but no other mental health disorders. About 22.0% of the respondents reported chronic diseases and 7.5% reported multimorbidity, which was found to be associated with higher odds of common probable mental health disorders (8, 15, 55). Acknowledging the multicollinearity between multimorbidity and probable mental health disorders (55), the current findings

should be replicated with the consideration of this issue. Medical professionals could be more sensitive to somatic symptoms, particularly among people experienced age-related deterioration in physical conditions in conjunction with work stress, burnout, and difficulty in adjustment to overtime work. Existing physical and psychiatric issues could further cause chronic pain and functional impairment (55), and increase physical and psychological burden. The PHC physicians and nurses in Central China reported lower odds of disorders which could be explained by their early exposure to the pandemic outbreak, as they received more support from across the nation (7) and could have more psychosocial resources to buffer against mental ill health (56). Contrarily, physicians/nurses in Southwestern China might be more disadvantaged given the region's developing economy and PHC sectors and the lower socioeconomic status of the physicians/nurses (7).

4.2.2 Work-related characteristics

Job duties and responsibilities were associated with higher odds of multiple probable mental health disorders among PHC physicians and nurses, who shouldered the burden of regular community health care services in conjunction with the implementation of national epidemic prevention and control policies (1, 2). The present findings showed that overtime work was associated with higher odds of common probable mental health disorders. The finding extended previous evidence on the positive association between long working hours and mental illnesses in different occupations (10) to PHC physicians and nurses during prolonged strict COVID-19 quarantine in China. Our results were also consistent with previous evidence (44, 57) on the adverse mental health impact of quarantine experiences among physicians/nurses during COVID-19. People within mandatory and stringent quarantine have reported immediate disruptions to their daily routines of work, exercise, and social activities, and various quarantine-induced stressors concerning health, finance, stigma, and employment could persist even after the pandemic and relate to mental health disorders (57, 58). This study added to previous evidence by assessing quarantine experiences that occurred 1–2 years and showing their prolonged adverse mental health impact in a national sample of PHC physicians and nurses.

4.2.3 Lack of workplace social support in primary health care

Social support has been widely recognized as a protective factor that was associated with lower symptoms of depression, anxiety, PTSD (15, 26), burnout, and quality of life among physicians/nurses. The current study provided additional evidence on the important positive link between social support-seeking behaviors and mental health in the often overlooked primary health care settings. Instead of focusing on the social support PHC professionals received, more attention should be given to facilitating their social support-seeking behaviors, which is an essential coping strategy that helps individuals develop more positive and effective coping strategies and psychological qualities, such as self-efficacy and positive appraisal (26). Such proactive coping with different stressors in PHC could contribute to overall psychological health (59). Despite the potentially important role of social support-seeking behaviors, it was previously found that as low as 12.7% of physicians sought help for their mental health during the COVID-19 outbreak (60), consistent with our findings that 10% of PHC physicians/nurses never sought support. Reluctance to seek help for mental health coupled with a shortage of psychologists (60) should be addressed systematically.

The present study has several limitations. First, causality could not be inferred due to the cross-sectional design. Second, our self-report survey method which could not preclude the possibilities of recall and social desirability biases, although the current instruments were validated and widely used. Third, the traumatic event was not specified in our measurement of PTSD, therefore we could not conclude that the scores reflected respondents' experiences with COVID-19 or related occupational conditions (61). Fourth, apart from the workplace, probable mental health disorders of healthcare professionals could be partially attributable to family issues, such as family distress, family support, and having family members infected (23, 62, 63). Fifth, there could be contextual biases or framing effects which may exist in studies targeting a particular workforce (32). Lower prevalence of mental health disorders was reported in occupation-specific populations with larger sample size compared to those collected in surveys, such as military personnel and police. Last but not least, the current study did not assess other common confounding variables that could influence mental health in COVID-19 such as COVID-19 infection history and perception of COVID-19 information release (64).

4.3 Conclusion and implications

Notwithstanding the limitations, the present study has several strengths. First, this national survey recruited one of the largest samples of nationally representative primary health care physicians and nurses using the stratified sampling method, covering both urban and rural areas across seven geographical regions and 30 provincial-level administrative regions in China. To the best of our knowledge, this is one of the first national studies on the mental health of PHC physicians and nurses in China. Second, our study extended the current literature by demonstrating the prolonged mental health impact of stringent infection control rules in the post-pandemic period, supplementing existing body of evidence for the early phase of the outbreak, within and beyond China.

Two years after the pandemic outbreak, under the prolonged strict quarantine measures in China, we observed an overall decreased prevalence of probable mental health disorders and insomnia in Chinese primary health care physicians and nurses, except for the increased probable in somatization, phobic anxiety, and obsessive-compulsive disorder. Primary health care workers might suffer long-term somatic symptoms despite the improvement in overall mental health. Burden and disrupted schedules due to overtime work and quarantine increased the odds of probable disorders. Mental health of primary health care professionals who were older, female, holding higher education degrees, or suffering from multimorbidity were more affected, especially those who did not seek social support. Our results call for attention from an organizational level to provide intervention and rehabilitation programs targeting primary health care physicians and nurses in need, so with the goal of enhancing their long-term

TABLE 3 Multiple logistic regression of risk factors associated with probable mental health disorders and insomnia.

Variable	Adjusted odds ratio (95% confidence interval)					
	Psychological distress	Probable somatization	Probable depression	Probable anxiety	Probable phobic anxiety	Probable obsessive-compulsive disorder
Gender						
Male	Ref	Ref	Ref	Ref	Ref	Ref
Female	**1.54 (1.14–2.08)**	**1.86 (1.37–2.52)**	**1.82 (1.29–2.56)**	**1.75 (1.17–2.61)**	**1.73 (1.16–2.59)**	**1.69 (1.19–2.40)**
Age	1.00 (0.99–1.02)	**1.02 (1.00–1.03)**	0.99 (0.98–1.01)	1.00 (0.98–1.02)	1.00 (0.98–1.02)	1.00 (0.98–1.02)
Region						
Central	Ref	Ref	Ref	Ref	Ref	Ref
Southeast	1.28 (0.99–1.64)	**1.39 (1.08–1.79)**	1.29 (0.96–1.72)	1.12 (0.79–1.60)	1.22 (0.87–1.71)	1.19 (0.89–1.6)
Southwest	**1.48 (1.10–2.01)**	**1.52 (1.12–2.07)**	1.24 (0.86–1.78)	1.48 (0.98–2.21)	1.36 (0.91–2.04)	1.36 (0.95–1.94)
Northeast	1.34 (0.90–1.98)	1.43 (0.96–2.12)	1.36 (0.86–2.14)	1.38 (0.82–2.34)	1.62 (1.00–2.64)	1.32 (0.83–2.08)
Northwest	1.17 (0.81–1.71)	1.27 (0.87–1.85)	1.29 (0.85–1.97)	1.29 (0.79–2.10)	1.43 (0.90–2.26)	1.23 (0.80–1.88)
Residence						
Rural	Ref	Ref	Ref	Ref	Ref	Ref
Urban	0.85 (0.63–1.15)	0.85 (0.62–1.15)	0.94 (0.67–1.33)	0.89 (0.59–1.34)	0.88 (0.60–1.31)	0.79 (0.55–1.13)
Education level						
Below bachelor	Ref	Ref	Ref	Ref	Ref	Ref
Bachelor or above	**1.43 (1.11–1.82)**	**1.39 (1.08–1.78)**	1.19 (0.89–1.59)	1.30 (0.92–1.83)	1.30 (0.95–1.81)	**1.39 (1.03–1.86)**
Occupation						
Doctor	Ref	Ref	Ref	Ref	Ref	Ref
Nurse	1.15 (0.90–1.47)	1.02 (0.80–1.30)	0.84 (0.64–1.12)	0.89 (0.64–1.25)	1.06 (0.77–1.45)	0.96 (0.73–1.28)
Overtime work						
Never and sometimes	Ref	Ref	Ref	Ref	Ref	Ref
More than half the time and almost everyday	**2.28 (1.85–2.81)**	**2.59 (2.10–3.19)**	**2.38 (1.87–3.04)**	**2.80 (2.11–3.71)**	**2.10 (1.60–2.76)**	**2.42 (1.90–3.08)**
Chronic disease						
No	Ref	Ref	Ref	Ref	Ref	Ref
Yes	1.02 (0.80–1.30)	0.94 (0.73–1.20)	0.97 (0.73–1.29)	0.87 (0.62–1.22)	0.97 (0.70–1.33)	0.94 (0.70–1.25)

(Continued)

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TABLE 3 (Continued)

Variable	Adjusted odds ratio (95% confidence interval)					
	Psychological distress	Probable somatization	Probable depression	Probable anxiety	Probable phobic anxiety	Probable obsessive-compulsive disorder
Multimorbidity						
No	Ref	Ref	Ref	Ref	Ref	Ref
Yes	**1.85 (1.33–2.58)**	**2.32 (1.69–3.18)**	**1.94 (1.34–2.82)**	**2.38 (1.57–3.61)**	**1.81 (1.18–2.77)**	**2.09 (1.44–3.02)**
Psychiatric history						
No	Ref	Ref	Ref	Ref	Ref	Ref
Yes	**7.06 (4.41–11.31)**	**5.52 (3.42–8.89)**	**8.97 (5.55–14.49)**	**9.73 (5.88–16.07)**	**6.84 (4.12–11.37)**	**7.13 (4.40–11.55)**
Quarantine experience						
No	Ref	Ref	Ref	Ref	Ref	Ref
Yes	**1.64 (1.33–2.03)**	**1.68 (1.36–2.08)**	**1.59 (1.25–2.03)**	**1.47 (1.10–1.96)**	**1.58 (1.20–2.07)**	**1.50 (1.17–1.92)**
Care from colleagues						
Care to some extent	Ref	Ref	Ref	Ref	Ref	Ref
Never care about each other	1.40 (0.96–2.05)	1.25 (0.84–1.85)	1.48 (0.97–2.25)	1.49 (0.93–2.36)	**2.00 (1.3–3.07)**	1.34 (0.87–2.06)
Emotional support-seeking behavior						
Tell others	Ref	Ref	Ref	Ref	Ref	Ref
Never tell anyone	**1.85 (1.34–2.56)**	**1.73 (1.24–2.42)**	**1.79 (1.24–2.58)**	**2.07 (1.37–3.12)**	**1.75 (1.17–2.62)**	**1.91 (1.32–2.77)**
Instrumental support-seeking behavior						
Ask others for help	Ref	Ref	Ref	Ref	Ref	Ref
Never ask anyone for help	**2.10 (1.53–2.88)**	**1.94 (1.40–2.68)**	**2.20 (1.53–3.14)**	**2.35 (1.57–3.53)**	**2.33 (1.57–3.44)**	**1.88 (1.30–2.71)**

(Continued)

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TABLE 3 (Continued)

Variable	Adjusted odds ratio (95% confidence interval)					
	Probable interpersonal sensitivity	Probable hostility	Probable paranoid ideation	Probable psychoticism	Probable post-traumatic stress disorder	Probable Insomnia
Gender						
Male	Ref	Ref	Ref	Ref	Ref	Ref
Female	1.42 (1.10,1.83)	1.48 (1.15,1.92)	1.34 (1.01,1.79)	1.19 (0.87,1.632)	**1.98 (1.35-2.90)**	**1.38 (1.08-1.76)**
Age	1.00 (0.99, 1.01)	1.01 (1.00, 1.02)	1.01 (0.99, 1.02)	1.00 (0.99, 1.02)	1.00 (0.98–1.02)	1.01 (0.99–1.02)
Region						
Central	Ref	Ref	Ref	Ref	Ref	Ref
Southeast	1.19 (0.96, 1.47)	1.22 (0.99, 1.51)	1.10 (0.86, 1.40)	1.31 (0.99, 1.72)	**1.49 (1.09–2.04)**	1.20 (0.98–1.47)
Southwest	1.27 (0.98, 1.66)	**1.31 (1.01, 1.70)**	**1.43 (1.07, 1.92)**	**1.68 (1.21, 2.33)**	**1.51 (1.03–2.21)**	1.23 (0.95–1.57)
Northeast	1.13 (0.80, 1.60)	**1.55 (1.12, 2.13)**	1.39 (0.96, 2.01)	**1.61 (1.06, 2.42)**	1.25 (0.75–2.07)	1.18 (0.86–1.64)
Northwest	0.97 (0.70, 1.36)	0.99 (0.71, 1.37)	1.06 (0.73, 1.52)	1.31 (0.88, 1.96)	1.16 (0.72–1.87)	1.02 (0.75–1.39)
Residence						
Rural	Ref	Ref	Ref	Ref	Ref	Ref
Urban	0.94 (0.73, 1.21)	0.98 (0.76, 1.25)	0.89 (0.67, 1.19)	0.95 (0.69, 1.30)	1.05 (0.73–1.51)	0.93 (0.73–1.18)
Education level						
Below bachelor	Ref	Ref	Ref	Ref	Ref	Ref
Bachelor or above	**1.25 (1.02, 1.52)**	1.41 (1.15, 1.72)	1.53 (1.22, 1.93)	**1.45 (1.12, 1.88)**	1.20 (0.88–1.63)	**1.29 (1.06–1.57)**
Occupation						
Doctor	Ref	Ref	Ref	Ref	Ref	Ref
Nurse	1.03 (0.84, 1.27)	1.14 (0.93, 1.40)	1.04 (0.83, 1.32)	1.10 (0.84, 1.43)	0.89 (0.66–1.19)	1.06 (0.87–1.29)
Overtime work						
Never and sometimes	Ref	Ref	Ref	Ref	Ref	Ref
More than half the time and almost everyday	1.86 (1.55, 2.24)	2.22 (1.85, 2.65)	2.00 (1.63, 2.46)	2.10 (1.67, 2.63)	**2.35 (1.81–3.05)**	**2.30 (1.93–2.73)**

(Continued)

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TABLE 3 (Continued)

Variable	Adjusted odds ratio (95% confidence interval)					
	Probable interpersonal sensitivity	Probable hostility	Probable paranoid ideation	Probable psychoticism	Probable post-traumatic stress disorder	Probable Insomnia
Chronic disease						
No	Ref	Ref	Ref	Ref	Ref	Ref
Yes	1.04 (0.85, 1.29)	1.06 (0.86, 1.30)	1.01 (0.80, 1.28)	1.14 (0.88, 1.48)	1.18 (0.88–1.59)	0.85 (0.69–1.05)
Multimorbidity						
No	Ref	Ref	Ref	Ref	Ref	Ref
Yes	**1.54 (1.14, 2.08)**	**1.45 (1.08, 1.96)**	**1.67 (1.20, 2.31)**	**1.73 (1.22, 2.46)**	**1.66 (1.12–2.48)**	**1.63 (1.22–2.17)**
Psychiatric history						
No	Ref	Ref	Ref	Ref	Ref	Ref
Yes	8.07 (5.03, 12.96)	**6.96 (4.33, 11.18)**	5.27 (3.31, 8.41)	7.45 (4.63, 11.97)	**6.97 (4.25–11.44)**	**5.96 (3.73–9.54)**
Quarantine experience						
No	Ref	Ref	Ref	Ref	Ref	Ref
Yes	1.38 (1.15, 1.67)	1.33 (1.10, 1.6)	1.58 (1.28, 1.94)	**1.44 (1.14, 1.81)**	**1.65 (1.27–2.15)**	**1.56 (1.31–1.86)**
Care from colleagues						
Care to some extent	Ref	Ref	Ref	Ref	Ref	Ref
Never care about each other	**1.48 (1.05, 2.09)**	1.29 (0.91, 1.83)	1.90 (1.33, 2.70)	**1.65 (1.12, 2.42)**	**1.72 (1.11–2.66)**	1.35 (0.96–1.90)
Emotional support-seeking behavior						
Tell others	Ref	Ref	Ref	Ref	Ref	Ref
Never tell anyone	1.73 (1.29, 2.31)	**1.45 (1.08, 1.95)**	**1.62 (1.18, 2.23)**	**1.43 (1.01, 2.02)**	1.48 (0.99–2.21)	**1.50 (1.13–1.99)**
Instrumental support-seeking behavior						
Ask others for help	Ref	Ref	Ref	Ref	Ref	Ref
Never ask anyone for help	**1.59 (1.19, 2.13)**	1.76 (1.32, 2.35)	1.92 (1.41, 2.63)	2.64 (1.90, 3.67)	**2.39 (1.63–3.50)**	**1.41 (1.06–1.87)**

Boldface indicates statistical significance ($p < 0.05$), Ref refers to reference group.

10.3389/fpubh.2024.1392845

physical and mental health and preparedness for future public health crises.

Data availability statement

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

Ethics statement

The studies involving humans were approved by The 7th Hospital of Wuhan (220701). The studies were conducted in accordance with the local legislation and institutional requirements. Electronic informed consent for participation in this study was provided before the data collection.

Author contributions

CL: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Software, Visualization, Writing – original draft, Writing – review & editing. YZ: Methodology, Conceptualization, Data curation, Project administration, Resources, Writing – review & editing. YG: Conceptualization, Methodology, Writing – review & editing. ZD: Methodology, Writing – review & editing. XC: Methodology, Writing – review & editing. YL: Methodology, Writing – review & editing. WW: Methodology, Writing – review & editing. TJ: Methodology, Writing – review & editing. QZ: Methodology, Writing – review & editing. LN: Methodology, Writing – review & editing. TT: Writing – review & editing. WH: Formal analysis, Methodology, Supervision, Writing – original draft, Writing – review & editing.

Funding

The author(s) declare financial support was received for the research, authorship, and/or publication of this article. This work was supported by Research Grants Council, University Grants Committee, Hong Kong SAR, China [Grant Number 18600320 (WH)]. The funding source had no role in any process of our study.

Acknowledgments

We would like to thank all the respondents who participated in this study.

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.

The author(s) declared that they were an editorial board member of Frontiers, at the time of submission. This had no impact on the peer review process and the final decision.

Publisher's note

Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpubh.2024.1392845/full#supplementary-material

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frontiers | Frontiers in Psychiatry

TYPE Original Research
PUBLISHED 03 September 2024
DOI 10.3389/fpsyt.2024.1415404

OPEN ACCESS

EDITED BY
Chong Chen,
Yamaguchi University Graduate School of Medicine, Japan

REVIEWED BY
Nora Althumiri,
Informed Decision Making, Saudi Arabia
Sevim Şen Olgay,
Yeditepe University, Türkiye
Seyhan Citlik Saritas,
Malatya Turgut Özal University, Türkiye

*CORRESPONDENCE
Zhengxiang Guo
2366037793@qq.com
Dongfang Ge
313401390@qq.com

RECEIVED 10 April 2024
ACCEPTED 07 August 2024
PUBLISHED 03 September 2024

CITATION
Wang X, Wang Y, Ge Y, Liu Y, Niu R, Guo Z and Ge D (2024) The Chinese version of the tendency to stigmatize epidemic diseases scale: a translation and validation study. *Front. Psychiatry* 15:1415404. doi: 10.3389/fpsyt.2024.1415404

The Chinese version of the tendency to stigmatize epidemic diseases scale: a translation and validation study

Xin Wang[1], Yuecong Wang[2], Yuanhui Ge[3], Yuxiu Liu[3], Riyu Niu[4], Zhengxiang Guo[1*] and Dongfang Ge[1*]

[1]Department of Nursing, Huaian Hospital of Huaian City, Huaian, China, [2]Department of Nursing, Huzhou University, Huzhou, China, [3]Department of Nursing, Jinzhou Medical University, Jinzhou, China, [4]Department of Infectious Diseases, Huaian Hospital of Huaian City, Huaian, China

Objective: To translate the Tendency to Stigmatize Epidemics Diseases Scale (TSEDS) into Chinese and to evaluate its psychometric properties.

Methods: Translation and cross-cultural adaptation using the Brislin translation model, and pre-testing to form a Chinese version of TSEDS. A total of 434 adults participated in the study and the TSEDS were measured using the critical ratio method, Pearson correlation analysis, retest reliability, content validity, structural validity, and concurrent validity.

Results: The Chinese version of the TSEDS scale contains 27 items in 5 dimensions, including structural stigma, perceived stigma, organizational stigma, internalized stigma, and social stigma. The average content validity index of the scale was 0.975. The goodness of fit index ($\chi 2/df$= 1.981, RMSEA = 0.067, CFI= 0.930, IFI = 0.931, TLI = 0.922) indicated a good model fit. The Cronbach's alpha coefficient was 0.962 and the dimensionality ranged from 0.882 to 0.928. The retest reliability was 0.912.

Conclusion: The Chinese version of TSEDS has good reliability and validity, which can be used to assess the epidemiological stigma tendency of Chinese adults.

KEYWORDS

infectious disease, stigma, translation, intercultural adaptation, psychometric assessment

1 Introduction

Infectious diseases are diseases that arise from infection of the human body by pathogenic microorganisms such as viruses, bacteria, fungi, and parasites such as protozoa and worms, which are contagious and can cause epidemics under certain conditions (1). They are the most serious category of diseases that endanger human health and lives (2). It is estimated that approximately 60 million people die globally each year, with at least 25% of these deaths due to infectious diseases (3, 4). Infectious diseases are characterized by complex routes of transmission, high infectiousness, widespread prevalence, and high morbidity (5). An infectious disease is considered an epidemic when it spreads quickly and impacts a large population; prevention and control of this disease is one of the most crucial public health concerns in the world. In 1980, the World Health Organization (WTO) declared the eradication of smallpox, but new threats soon emerged. The AIDS epidemic began in 1981, and the severity of tuberculosis increased with it (6). In 2002, an outbreak of contagious atypical pneumonia (SARS) occurred in Guangdong, China, and quickly spread around the world, with a fatality rate of up to 10% (7). Middle East Respiratory Syndrome (MERS), which broke out in Saudi Arabia in 2012 and has since spread to more than 20 countries worldwide, has a mortality rate of up to 34% (8). To this day, COVID-19 continues to spread, to the detriment of human life, property, health, and safety, and to new challenges to global economic development (9). The WTO states that infectious diseases need to be closely monitored to ensure prevention, promote early detection, and reduce further transmission. The public is prone to prejudice against people with infectious diseases, and patients themselves can have negative psycho-emotional reactions. It has been found that when epidemics associated with infectious diseases such as COVID-19 (10), syphilis (11), AIDS (12), and tuberculosis (13)occur, patients develop different characteristics of disease stigma.

Stigma, also known as "stigma feelings", refers to the negative emotional reactions that the experiences patients have due to their illness (14). It was first introduced into the field of psychology by American sociologist Goffman in 1963 (15). Stigma is a social phenomenon that occurs when individuals, usually those in groups with low self-esteem, are discriminated against because of their medical condition, leading to stereotyping, labeling, isolation, and lowered status (16). Chinese research population on disease stigma has focused on breast cancer (17), epilepsy (18), and psychiatric disorders (19). Some scholars have also explored the stigma associated with some chronic infectious diseases, such as the fact that stigma can lead to a decrease in self-esteem and self-confidence among AIDS patients, which seriously affects their quality of life (20). The more TB-related stigma, the higher the chance of patients having depressive symptoms (21). Hepatitis-B infected people have different degrees of stigma, which seriously affects their interpersonal relationships and job search (22). Stigma can lead to deterioration of physical and mental health, such as anxiety, depression, mental and emotional distress, and reduced quality of life. High levels of stigma have a significant impact on health, with patients avoiding healthcare services, thereby increasing the transmission of infectious diseases (23).

At present, China mostly uses scales for specific infectious diseases, such as the Chinese version of the AIDS Perceived Discrimination Scale (24), the Tuberculosis Stigma Perception Scale (25), and the Discrimination Measurement Scale for People with Chronic Hepatitis B Virus (26). However, these scales are all developed for specific infectious diseases and are difficult to fully reflect the stigmatization experienced by adults in different epidemic contexts. In view of the frequent occurrence of global epidemics and their widespread psychosocial impact, there is an urgent need for a non-disease-specific scale that can be used across cultural and epidemic contexts to accurately assess the extent of epidemic stigmatization. Sevim et al. developed the Tendency to Stigmatize Epidemic Diseases Scale(TSEDS) in 2014, the accuracy and reliability of these findings have been validated in a Turkish adult population, which is essential for controlling epidemics and protecting public health and safety (27). The TSEDS scale is a new, non-disease-specific measurement tool that can be used in different epidemics to help healthcare professionals understand epidemic-related social emotions and behaviors and to develop policies to reduce stigma during epidemics to provide rapid and timely interventions. Therefore, translating the TSEDS into Chinese and conducting cultural adaptation verification not only fills the gap in this field in China, but also provides strong support for the formulation of public health policies and the implementation of rapid intervention measures. As suggested by the original authors, TSEDS can be validated for applicability by conducting reliability and validity studies in different countries and cultural contexts.

Therefore, the aim of this study was to translate the English version of the TSEDS into Chinese with cross-cultural adaptation, to assess the psychometric properties of the TSEDS Chinese version in a Chinese community-based adult population. This has not only enriched the theoretical framework for the study of epidemic stigma in China, but also provided a scientifically valid measurement tool for subsequent studies. To more systematically assess the status of epidemiological stigma in China and to provide a rational basis for the development of effective interventions. By applying the TSEDS in different epidemic contexts, we can better understand the psychosocial mechanisms of epidemic stigma and provide empirical evidence for formulating more accurate and effective public health intervention strategies. In addition, this study will promote international exchanges and cooperation in the field of epidemiological stigma research to jointly address global public health challenges.

2 Methods

2.1 Study design and participants

This study was a cross-sectional study. A questionnaire survey was conducted from February to March 2024 using a convenience sampling method among adults in five communities in Huaian City, Jiangsu Province, China. There are 115 communities in the city of Huaian, in order to increase the representativeness of the sample and the accuracy of the research, we selected five communities with relatively active community activities and a relatively complete

organizational structure for sampling. These communities are not only evenly distributed geographically, covering different areas of Huai'an City, but also exhibit a certain diversity in socio-economic status, population density, and residents' health status. The selection of these communities helps us to better understand the medical behavior and psychological status of adults in Huai'an City during the COVID-19 outbreak. As for the respondents, we selected the closest and most accessible eligible adults to ensure that we collected as much valid data as possible in the limited time available. Inclusion criteria: (1) aged 18-59 years; (2) receiving inpatient or outpatient treatment during the COVID-19 epidemic (3) mentally alert and able to understand the questionnaire; (4) informed consent and voluntary participation in this study. Exclusion criteria: people with severe mental illness.

2.2 Instruments

2.2.1 Questionnaire on general demographic characteristics

The study was designed according to the content and purpose of the study, including age, gender, education level, average monthly income, marital status, and treatment methods during the COVID-19 epidemic.

2.2.2 Tendency to stigmatize epidemic diseases scale

The scale was developed by Sevim (27) to assess the level of stigma among adults during the epidemic. The scale consists of 27 items and 5 dimensions: structural stigma (7 items), perceived stigma (6 items), organizational stigma (3 items), internalized stigma (6 items), and social stigma (3 items). A Likert scale with 5 points ranging from 1 (strongly disagree) to 5 (strongly agree) was used. Total scores ranged from 27 to 135, with higher scores indicating a greater tendency to epidemiological stigma. The original scale had a Cronbach's α coefficient of 0.88.

2.2.3 Self-esteem scale

The scale was developed by Rosenberg (28) and the Chinese version by Ji et al. in 1993 (29). It is one of the more influential instruments for measuring an individual's level of self-esteem. Contains 10 entries on a single dimension using a 4-point Likert scale from 1 (completely disagree) to 4 (completely agree). Total scores range from 10-40, where higher scores represent greater levels of individual self-esteem. The Cronbach's α coefficient for SES was 0.900, and for the scale in this research, it was 0.873. SES was used to measure concurrent validity.

2.3 Procedures

2.3.1 Translation and cultural adaptation

After getting approval from the original author, Professor Sevim, via email, the original scale was translated as well as cross-culturally adapted to creat the Chinese version of the TSEDS, strictly following the Brislin Translation Model (30).

Positive translation of the questionnaire: the English translation of TSEDS was done independently by two nursing graduate students who had passed CET-6 and whose mother tongue was Chinese, and the results of the two translations were synthesized by a nursing psychology faculty member, who formed the Chinese version of TSEDS-1 with the unified opinion of the group.

Back-translation of the questionnaire: Two professors from the English Department with no medical background and no previous exposure to the scale were invited to back-translate the TSEDS-1 into Chinese, and members of the group summarized the two back-translated versions of the scale, which were discussed to form the Chinese version of the TSEDS-2.

The questionnaire was adapted for cross-cultural use by consulting eight experts: three specializing in epidemiology, three in nursing, and two in psychology. Four of them had PhDs and four had master's degrees. A Likert 4-point scale was used to score the clarity of semantic expression, the relevance of the content of the entries, and the degree of compliance with the cultural context of each entry of the scale and to propose relevant modifications, resulting in the Chinese version of the TSEDS-3.

Pre-survey: 30 adults were invited to participate in a survey to validate the clarity and comprehension of the translated scale items. The results indicated that the scale was easy to understand and easy to fill in (filling in time was about 5 min), thus resulting in the final Chinese version of the TSEDS.

2.3.2 Data collection

Before data collection, all researchers involved were uniformly trained to ensure that everyone was familiar with the questionnaire questions and their meanings, as well as the steps and precautions for unified data collection. Questionnaire collection was conducted in five communities to clarify the inclusion criteria of participants and to minimize potential bias by ensuring that participants were evenly distributed by age and gender. The researcher explained the content, purpose, and significance of the questionnaire to the participants before handing it out, and distributed the paper questionnaire on the spot. The average time to fill out the questionnaire was determined by pre-testing to be about 10 minutes, and on-site supervision was conducted to ensure that each participant had enough time to carefully fill it out. The survey was conducted anonymously to protect participants' privacy and encourage them to provide truthful and objective responses. Only the personal contact information of 30 adults was retained so that a second survey could be conducted two weeks later to measure the retest reliability of the scale. The questionnaire was collected on site immediately after completion to ensure data integrity and timeliness.

According to the criteria proposed by Kendall (31), a sample size of at least 5-10 times the scale items and a minimum of 200 cases is required for validated factor analyses (CFA) (32). A total of 27 items in the Chinese version of TSEDS were used in this research. Considering a 10% invalid sample size, 450 adults were enlisted for

study participation, resulting in the recovery of 434 questionnaires after eliminating invalid ones, yielding a valid recovery rate of 96.44%.

3 Data analysis

3.1 Statistical analysis

The data of this study was entered by two persons using Excel software and statistically analyzed using SPSS 27.0 and AMOS 24.0. Demographic characteristics were analyzed using descriptive statistics (mean ± standard deviation of continuous data, frequencies, and percentages of demographic characteristics). When the skewness and kurtosis values of the items were within ±2 (33), the data were considered normally distributed. This study used critical ratio method and correlation coefficient method to measure item analysis, internal consistency reliability and rest-retest reliability to measure reliability analysis, and correlation validity, construct validity, and concurrent validity to measure validity analysis.

3.2 Item analysis

3.2.1 Critical ratio method

An independent samples t-test was employed to separate the top 27% (high group) and the bottom 27% (low group) of the Chinese TSEDS total scores, which were arranged from low to high. The item was kept when the CR value was >3.0 and $p < 0.05$ (34).

3.2.2 Correlation coefficient method

The correlation coefficients of the items with the scale's overall score were analyzed, and the items with correlation coefficients <0.4 or no significant difference were excluded. The correlation coefficients between the items and the total score were computed, and the Cronbach's α values follow deleting the items. If the Cronbach's α value increased after the deletion of the item, the item could be eligible for deletion (35).

3.3 Reliability analysis

3.3.1 Internal consistency reliability

Corrected item-total correlation and Cronbach's α coefficient were used. Acceptable Cronbach's α coefficients were defined as ≥0.70 and a standardized adjusted item-total correlation value of >0.3 (35).

3.3.2 Test-retest reliability

Thirty participants who completed the first test were randomly selected for a retesting two weeks after the initial questionnaire. Correlation analyses of the results of the two surveys were conducted using Pearson correlation to test the retest reliability of the scale. The scale reliability was considered to be good, when the retest reliability was >0.75 (35).

3.4 Validity analysis

3.4.1 Content validity

A 4-point Likert scale was used to assess the application, relevance, and completeness of the concepts, standards, and semantics of the Chinese version of TSEDS by eight experts with relevant experience: not relevant (one point), low relevance (two points), medium relevance (three points), and strong relevance (four points). According to the Delphi method, when the Scale-Content Validity Index (S-CVI) at the scale level is >0.900 and the Item-Content Validity Index (I-CVI) at the item level is >0.780, the scale has strong content validity (36).

3.4.2 Construct validity

To explore the underlying factor structure of the translated questionnaire, the structural validity of the TSEDS was examined using validation factor analysis (CFA) and exploratory factor analysis (EFA). 434 adults in total, with 217 participants in each group, were randomly assigned to the EFA and CFA groups.

In sample 1 (n=217), exploratory factor analysis (EFA) was carried out. When the Bartlett sphericity test was statistically significant ($p < 0.05$) and Kaiser-Meyer-Olkin (KMO) was >0.60, factor analysis was suitable (37). The orthogonal rotation approach and principal component analysis were utilized to extract common elements with eigenvalues greater than 1.

In Sample 2 (n=217), a validation factor analysis (CFA) was performed using AMOS to confirm that the model structure and the factor structure under investigation were consistent. The maximum likelihood approach was used for estimation, and the following metrics were used to calculate the model fit indices: chi-square degrees of freedom ($\chi 2/df$) < 3.0, comparative fit index (CFI) > 0.9, index of value-added fit (IFI) > 0.9, Tucker-Lewis index (TLI) > 0.9, and root mean square of the error of approximation (RMSEA) < 0.08 indicating that the model fit was within an acceptable range (38).

3.4.3 Concurrent validity

SES was used as a calibration tool in this study to evaluate the correlation coefficients between the scale scores and other variables since it is commonly used and has strong reliability and validity. The degree of correlation between variables can be assessed based on the correlation coefficient's magnitude and absolute value. It is best when the correlation coefficient's absolute value falls between 0.4 and 0.7 (39).

3.5 Ethical approval

The research was granted approval by Jinzhou Medical University's Ethics Committee (consent number: JZMULL20240708), and and every subject filled out an informed consent form.

4 Results

4.1 Demographics and sample characteristics

A total of 434 adults were enrolled, of whom 225 (51.8%) were female; 130 (30.0%) were aged 18-29 years; 293 (67.5%) were

married; 293 (67.5%) had a university degree or higher; 184 (42.4%) had an average monthly income of $3,000-$5,000; and 371 people (85.5%) chose outpatient treatment during the COVID-19 pandemic. See Table 1 for details.

4.2 Item analysis

Each item's CR value ranged from 11.779 to 26.805 (>3.0) according to the critical ratio method, all of which were statistically significant ($p < 0.001$). All correlation coefficients were greater than 0.4, and the range of correlations between the items and the scale's overall score was 0.588 to 0.773 ($p < 0.01$). Furthermore, the total Cronbach's α coefficient for the scale decreased upon the removal of any item. These findings show that all 27 elements were kept from the Chinese version of the TSEDS entries, which demonstrated good discrimination. See Table 2 for details.

4.3 Reliability analysis

The Cronbach's α coefficients for the dimensions varied from 0.882 to 0.928, while the total Cronbach's α coefficient was 0.962. All of the items had corrected item-total correlations that were greater than 0.3, ranging from 0.553 to 0.750. A follow-up test was conducted on thirty persons after two weeks to assess the scale's reliability, the retest reliability was 0.912. The participants' mean (SD) scores for each item in the TSEDS's Chinese version are displayed in Table 3. These had a normal distribution based on skewness and kurtosis.

TABLE 1 Demographic characteristics of participants (N = 434).

	Variable	N	%
Gender	Male	209	48.2
	Female	225	51.8
Age group (years)	18-29	130	30.0
	30-39	112	25.8
	40-49	106	24.4
	50-59	86	19.8
Marital status	Single	125	28.8
	Married	293	67.5
	Divorced or widowed	16	3.7
Educational level	Primary school and below	52	12.0
	Junior and senior high schools	89	20.5
	College degree or above	293	67.5
Monthly income (yuan)	<3000	153	35.3
	3000-5000	184	42.4
	>5000	97	22.4
Treatment during the COVID-19 pandemic	Outpatient treatment	371	85.5
	Receive hospital treatment	63	14.5

4.4 Validity analysis

4.4.1 Content validity

The findings demonstrated that the S-CVI was 0.95 and the I-CVI ranged from 0.84 to 1.00, indicating that the questionnaire's content validity was good.

4.4.2 Construct validity

Exploratory factor analysis (EFA): The Bartlett sphericity test approximate chi-square for this study was 4555.604 ($p < 0.001$) and the KMO value was 0.947 (> 0.6), making it suitable for factor analysis. After applying the data to PCA with maximum variance orthogonal rotation, five factors with eigenroots > 1 were extracted, with the same number of factors as in the original scale. The cumulative variance contribution was 72.045%, with each item loading value > 0.4. The loading matrices of the factors are shown in Table 4. The gravel plot, which shows a weaker decreasing trend after point 5, helps to further illustrate the structure of the five variables. In Figure 1, the gravel plot is displayed.

Confirmatory factor analysis (CFA): the validation results showed good results in this study. The indicators' values are as follows: $\chi 2/df = 1.981$, CFI = 0.930, TLI = 0.922, IFI = 0.931, and RMSEA = 0.067. The CFA results are shown in Figure 2.

4.4.3 Concurrent validity

Between the SES total score and the Chinese version of the TSEDS total score, the absolute value of the Pearson correlation coefficient was 0.579 ($p < 0.01$), a statistically significant difference indicating a high degree of correlation.

5 Discussion

One of the reasons why fewer studies on epidemic disease stigma have been reported in China is the dearth of measurement instruments for epidemic disease stigma tendencies. To scientifically and validly assess adults' propensity to feel stigma during the epidemic, we translated the TSEDS from English into Chinese and conducted comprehensive psychometric analyses, including item analyses, reliability analyses, and validity analyses, on 434 adults. The scale applied for the first time to the Chinese population, has good reliability and validity, helping to identify the tendency of adults to feel stigma during the epidemic and prompting healthcare professionals to give timely and targeted interventions to reduce patients' negative emotions and improve their mental and physical health.

One of the most important phases in the process of revising the scale is item analysis, as it contributes to the quality of the test items (34). The CR values of the 27 items in this study were all >3.0 ($p < 0.001$), demonstrating a significant level of scale discrimination. Every item's correlation coefficient and the scale's overall score were all more than 0.588, showing a medium to high correlation. In

TABLE 2 Score comparison between high-score and low-score groups, item analysis (N=434).

Item	Low-score group (n=117),mean (SD)	High-score group (n=129),mean (SD)	Critical ratio	Item-total correlation	Cronbach's alpha if item delete
1	2.60(0.492)	3.83(0.663)	16.400**	0.624**	0.961
2	1.97(0.804)	3.86(0.778)	18.693**	0.687**	0.961
3	2.23(0.792)	3.91(0.718)	17.403**	0.620**	0.961
4	2.52(0.794)	3.98(0.696)	15.299**	0.650**	0.961
5	2.58(0.757)	4.08(0.714)	15.953**	0.665**	0.961
6	1.93(0.751)	3.83(0.782)	19.371**	0.723**	0.960
7	2.26(0.700)	4.05(0.653)	20.672**	0.724**	0.960
8	1.88(0.790)	4.09(0.643)	23.955**	0.769**	0.960
9	1.91(0.841)	4.06(0.693)	22.024**	0.747**	0.960
10	2.09(0.847)	4.03(0.695)	19.580**	0.699**	0.961
11	1.73(0.567)	3.92(0.703)	26.805**	0.767**	0.960
12	2.19(0.642)	4.16(0.618)	24.466**	0.732**	0.960
13	2.14(0.681)	4.08(0.853)	19.797**	0.735**	0.960
14	1.77(0.747)	3.75(0.848)	19.371**	0.745**	0.960
15	1.60(0.631)	3.17(0.945)	15.479**	0.721**	0.960
16	1.37(0.581)	3.34(0.940)	20.006**	0.744**	0.960
17	1.54(0.550)	3.49(0.876)	21.108**	0.773**	0.960
18	1.55(0.549)	3.53(0.820)	22.426**	0.759**	0.960
19	1.72(0.668)	3.84(0.908)	20.981**	0.759**	0.960
20	1.69(0.533)	3.63(1.008)	19.065**	0.766**	0.960
21	2.44(1.086)	3.81(0.650)	11.779**	0.588**	0.961
22	1.62(0.628)	3.26(1.099)	14.541**	0.736**	0.960
23	1.59(0.645)	3.36(0.865)	18.337**	0.708**	0.960
24	1.95(0.797)	3.83(0.802)	18.427**	0.705**	0.960
25	2.26(0.767)	3.64(0.918)	12.825**	0.658**	0.961
26	1.83(0.673)	3.26(0.886)	14.293**	0.674**	0.961
27	1.92(0.672)	3.33(0.953)	13.434**	0.645**	0.961

**$p<0.01$.

addition, after removing the items, the translated scale's Cronbach's α coefficient dropped, demonstrating a high degree of internal consistency and a strong connection between the components. It suggests that all 27 items in the TSEDS's Chinese translation have good discriminability and can better reflect the tendency of disease stigma during the adult epidemic, and all of them can be retained.

Reliability refers to the stability and consistency of the results measured by a scale, and the greater the reliability of a scale, the smaller its standard error of measurement. The Cronbach's α coefficients of the Chinese version of the TSEDS and the dimensions in this study meet the reference standard, indicating that the scale has high internal consistency reliability (35). Compared with the original scale, the Cronbach's α coefficients of the Chinese version of the TSEDS are higher than those of the original scale (27). This may be related to the fact that China has a large population base and the the rapid spread of the epidemic is more likely to cause stigmatization. Every item's correlation coefficient with the overall score was greater than 0.4, indicating good internal consistency of the scale (35). In the meantime, the retest reliability was strong, demonstrating the TSEDS's longitudinal stability in Chinese. Therefore, the TSEDS in Chinese has good reliability.

Validity is the validity or accuracy of a scale's findings (36). The content validity, structural validity, and concurrent validity of the Chinese version of the TSEDS were assessed in this study. Eight experts from the fields of epidemiology, nursing, and psychology were invited to evaluate the content's validity. The values of the I-CVI and the S-CVI were within a reasonable range (36). This

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TABLE 3 Mean (SD) scores with skewness and kurtosis, reliability analysis (N=434).

Factor	Item	Mean(SD)	Skewness	Kurtosis	Corrected item-total correlation	Cronbach's α coefficient
Factor 1	1	3.29(0.784)	-0.045	-0.598	0.599	0.888
	2	2.94(1.045)	0.013	-0.736	0.658	
	3	3.08(0.997)	-0.162	-0.728	0.587	
	4	3.35(0.911)	-0.257	-0.226	0.622	
	5	3.34(0.918)	-0.212	-0.278	0.638	
	6	2.99(1.028)	-0.148	-0.536	0.697	
	7	3.25(0.970)	-0.262	-0.393	0.699	
Factor 2	8	3.01(1.183)	-0.026	-0.990	0.742	0.928
	9	2.97(1.160)	0.032	-0.979	0.720	
	10	3.16(1.100)	-0.151	-0.824	0.669	
	11	2.85(1.162)	0.175	-0.864	0.741	
	12	3.27(1.051)	-0.249	-0.624	0.706	
	13	3.15(1.101)	0.112	-0.980	0.708	
Factor 3	14	2.80(1.083)	0.109	-0.925	0.719	0.916
	15	2.41(0.953)	0.406	-0.394	0.697	
	16	2.39(1.087)	0.421	-0.671	0.718	
	17	2.49(1.033)	0.435	-0.534	0.750	
	18	2.44(1.048)	0.474	-0.675	0.736	
Factor 4	19	2.67(1.171)	0.409	-0.847	0.732	0.905
	20	2.61(1.048)	0.528	-0.370	0.743	
	21	3.23(1.006)	-0.697	-0.408	0.553	
	22	2.33(1.029)	0.861	0.086	0.710	
	23	2.42(1.033)	0.407	-0.744	0.681	
	24	2.96(1.112)	-0.080	-0.970	0.675	
Factor 5	25	3.02(0.957)	0.054	-0.583	0.630	0.882
	26	2.47(0.932)	0.370	-0.365	0.647	
	27	2.59(0.968)	0.434	-0.376	0.615	

suggests that the items of the Chinese version of the TSEDS can effectively respond to the tendency to feel stigma during the adult epidemic. The degree to which a scale is integrated with the theoretical or conceptual framework that forms its basis is reflected in its structural validity (37). Five metric factors were recovered from the EFA without removing any entries, and the entries for every dimension were consistent with the original scale, with a cumulative variance contribution of 72.045%. Five factors were shown in the Chinese version of the TSEDS: structural stigma, perceived stigma, organizational stigma, internalized stigma, and social stigma. The translation scale's structure was further verified in this study using CFA, and the fitting index met the ideal criteria, demonstrating the scale's strong structural validity (38). In addition, concurrent validity analyses indicated that there was a correlation between the Chinese version of the TSEDS and the SES scores ($p < 0.05$), suggesting that the scale has good concurrent validity.

The first factor is structural stigma, which emphasizes inequity in health services. Every member of society, regardless of his or her occupation, income, etc., should have equal access to the health services that he or she needs, such as prevention, medical treatment, and health care. However, the problem of inequity in public health services in the field of infectious diseases is still relatively serious at present, and the general public is reluctant to share public transport with patients with infectious diseases and would like to keep a distance from them, indicating that the public health service system needs to be strengthened to ensure that all members of society have equal access to the preventive, medical, and health services they need, and to promote public education in order to increase social

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TABLE 4 Factor loadings of the TSEDS (N = 217).

Item	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
10	0.774				
9	0.756				
12	0.753				
8	0.747				
11	0.720				
13	0.671				
2		0.787			
7		0.723			
4		0.693			
5		0.677			
3		0.590			
1		0.587			
6		0.546			
16			0.774		
15			0.767		
18			0.763		
17			0.700		
14			0.562		
21				0.773	
23				0.728	
19				0.647	
24				0.643	
22				0.626	
20				0.588	
27					0.841
26					0.788
25					0.757

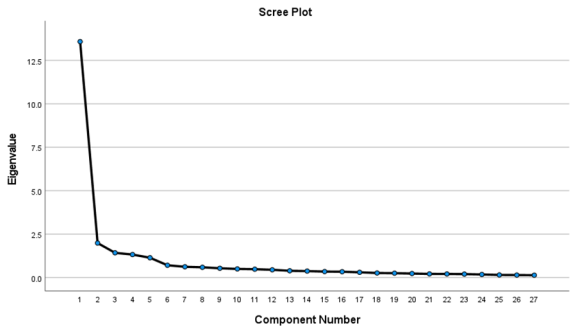

FIGURE 1
Screen plot of exploratory factor analysis for the Chinese version of the TSEDS (n = 217).

understanding and acceptance of those affected by the epidemic, and reduce unnecessary discrimination and exclusion. The second factor is perceived stigma, which is the individual's feelings of shame, including negative emotions such as embarrassment, guilt, loneliness, resentment, and fear. These negative emotional impacts may have important implications for the effectiveness of diagnosis and treatment of diseases in people with infectious diseases and may lead to delays in healthcare seeking, resulting in delays in diagnosis and initiation of treatment, increasing the contagiousness of the disease, and affecting the health of the individual as well as that of others (40). The resultant perceived stigma may also lead to the avoidance of social activities, and ultimately to social isolation. Medical institutions need to carry out mental health education activities to help infectious disease patients and their families correctly understand and cope with the negative emotions brought by the disease, as well as enhance their psychological resilience. They should establish a professional psychological counseling and support system to provide timely psychological assistance and counseling for patients with infectious diseases. Medical staff are encouraged to pay attention to the psychological needs of patients in the treatment process and provide comprehensive medical and psychological support.

The third factor is organizational stigma, which refers to the issues that may be experienced in places of public institutions such as hospitals, apartment buildings, and lifts. Some members of the public do not want to share the public sphere with people with infectious diseases, and public rejection and discrimination may increase the negative experiences and experiences of people with infectious diseases, resulting in avoidance of psychology and behaviors that cause a range of mental health problems. Health management and publicity in public places should be strengthened to raise public awareness of epidemic prevention and control. A non-discrimination policy should be developed and implemented in public places to ensure equal access to public facilities and services for persons affected by or living with epidemics. Public institutions should be encouraged and supported to carry out care activities for these individuals, in order to reduce their feelings of isolation and exclusion. The fourth factor is internalized stigma, whereby the stigmatized individual accepts and rationalizes the negative perceptions that others have of the disease. Individuals with an infectious disease close themselves off psychologically and operationally, fail to accept themselves well evaluate themselves positively, and gradually alienate themselves from their loved ones and friends. Communities and medical institutions can provide mental health education and counseling services to help individuals affected by or living with epidemics develop a positive sense of self-identity and self-worth. Encourage patients to participate in social activities, keep in touch with friends and family, and thereby reduce psychological estrangement and loneliness. Develop patient support groups or online communities where patients can share experiences, encouragement, and support with each other. The fifth factor is social stigma, which manifests the intolerant behaviors and attitudes of society experienced by individuals with infectious diseases. Increase public understanding and empathy for those affected by the epidemic, and reduce discrimination and

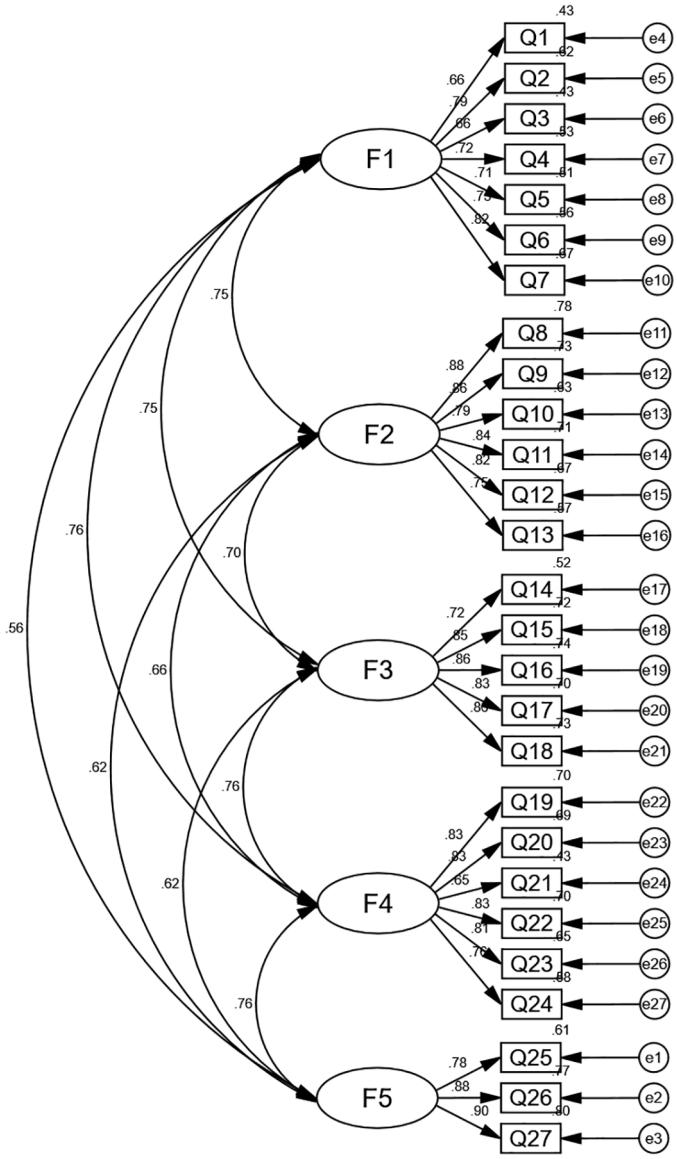

FIGURE 2
Standardized five-factor structural model of the Chinese version of the TSEDS (n = 217). F1: Structural stigma; F2: Perceived stigma; F3: Organizational stigma; F4: Internalized stigma; F5: Social stigma.

prejudice through media campaigns and educational activities. Promote social inclusion and acceptance, and encourage all sectors of society to provide support and help for epidemic patients. Develop and implement anti-discrimination laws and regulations to protect the legitimate rights and interests of epidemic patients from infringement.

The Chinese version of the TSEDS has been analyzed for item analysis, validity, and reliability. It can be used to measure the propensity to feel stigmatized during epidemics among Chinese adults. This scale is good for encouraging the development of policies to reduce stigma during epidemics, as well as providing healthcare professionals with an understanding of epidemic-related social emotions and behaviors, and timely interventions to reduce the problem of stigma.

This study does, however, have certain limitations. Firstly, the study's participants were from five communities in Huaian, and therefore not fully representative of the diversity of Chinese adults. Further expansion of the sample size is needed to improve the applicability of the scale in the future. Furthermore, as the TSEDS is a self-report measure, bias in the results is inevitable.

6 Conclusion

The Chinese version of the TSEDS has clear entries and consists of five factors: structural stigma, perceived stigma, organizational stigma, internalized stigma, and social stigma. It has good validity, reliability, and psychometric characteristics. It can be used as an effective tool for the epidemiological stigma tendency of Chinese adults.

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 humans were approved by the ethics committee of Jinzhou Medical University. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

XW: Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Methodology, Investigation, Data curation, Conceptualization. YW: Writing – review & editing, Investigation. YG: Writing – review & editing, Investigation. YL: Writing – review & editing, Investigation. RN: Writing – review & editing, Validation. DG: Writing – review & editing, Supervision, Project administration. ZG: Writing – review & editing, Supervision, Project administration.

Funding

The author(s) declare that no financial support was received for the research, authorship, and/or publication of this article.

Acknowledgments

The cooperation of all the participants who volunteered to participate in this study is appreciated. The authors are also grateful to the hard-working editors and reviewers for their valuable comments and suggestions.

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/fpsyt.2024.1415404/full#supplementary-material

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frontiers | Frontiers in Public Health

TYPE Original Research
PUBLISHED 13 February 2025
DOI 10.3389/fpubh.2025.1387213

OPEN ACCESS

EDITED BY
Chong Chen,
Yamaguchi University Graduate School of Medicine, Japan

REVIEWED BY
Morteza Taheri,
University of Tehran, Iran
Mustafa Kursat Sahin,
Ondokuz Mayıs University, Türkiye

*CORRESPONDENCE
Seyed Saeed Hashemi Nazari
✉ saeedh_1999@yahoo.com

RECEIVED 17 February 2024
ACCEPTED 14 January 2025
PUBLISHED 13 February 2025

CITATION
Nouhi Siahroudi A, Hashemi Nazari SS, Namdari M, Panahi MH, Mahdavi SA and Khademi A (2025) The effect of COVID-19 on completed suicide rate in Iran: an Interrupted Time Series study.
Front. Public Health 13:1387213.
doi: 10.3389/fpubh.2025.1387213

The effect of COVID-19 on completed suicide rate in Iran: an Interrupted Time Series study (ITS)

Azadeh Nouhi Siahroudi[1], Seyed Saeed Hashemi Nazari[1]*, Mahshid Namdari[1], Mohammad Hossein Panahi[1,2], Seyed Amirhosein Mahdavi[3] and Ali Khademi[4]

[1]Department of Epidemiology, School of Public Health and Safety, Shahid Beheshti University of Medical Sciences, Tehran, Iran, [2]Safety Promotion and Injury Prevention Research Center, Shahid Beheshti University of Medical Sciences, Tehran, Iran, [3]Legal Medicine Research Center, Legal Medicine Organization of IRAN, Tehran, Iran, [4]Legal Medicine Research Center, Iranian Legal Medicine Organization, Tehran, Iran

Background: Suicide represents a critical public health concern and one of the most devastating forms of death. Based on a report from the World Health Organization, around 700,000 deaths by suicide occur globally each year. In 2019, the worldwide suicide mortality rate was 9.0 per 100,000 people, while in Iran, this rate has been reported to be an average of 5.2 per 100,000. Suicide is influenced by various factors spanning individual, relational, community, and social domains, all of which may elevate the risk of suicide and related death. One significant factor potentially impacting this issue was the COVID-19 pandemic, which may have affected these trends by disrupting individuals' social interactions and gatherings. To explore this further, the present study was carried out to investigate the impact of the COVID-19 pandemic on the changes in suicide rates leading to death in Iran.

Methods: This study was designed using an Interrupted Time Series approach combined with negative binomial regression. Seasonal variations were adjusted for using the harmonic method. The research sample comprised 63,514 suicide-related deaths recorded between April 20, 2009, and March 20, 2023. Suicide mortality data were sourced from the National Legal Medicine Organization, while population statistics were obtained from the official website of the Statistical Center of Iran. The study analyzed trends in suicide incidence both prior to and during the COVID-19 pandemic. The period used to evaluate pandemic-related changes in Iran began in May 2020, following the World Health Organization's declaration of COVID-19 as a global public health emergency. Descriptive analyses were performed using Stata software, and trend assessments through the Interrupted Time Series (ITS) method were conducted using R software and the "lmtest" statistical package.

Results: The changes in the incidence of suicide during the study increased by 1.003 monthly ($p < 0.001$). This rate increased by 1.1 ($p < 0.001$) compared to the times before the onset of the pandemic after entering the effect of the COVID-19 pandemic in the model. When the interaction effect of time with the COVID-19 pandemic was added to the base model, no significant relationship was observed.

Conclusion: Before the COVID-19 pandemic, suicides in Iran had a proportional increasing trend. However, three months after the pandemic, an increasing

trend in the level of suicide deaths was observed. Most likely, the COVID-19 pandemic phenomenon had an impact on the occurrence of suicide.

KEYWORDS

complete suicide, COVID-19 disease, Interrupted Time Series method, Iran, Rate incidence

Introduction

Suicide has been a significant public health concern impacting individuals of all ages, genders, and regions (1–3). According to the latest report of the World Health Organization, more than 700,000 people lose their lives due to suicide every year (4). The age standardized suicide rate in the world was 9.0 per 100,000 population in 2019, which varied between countries from less than two to more than 80 per 100,000 population. In terms of age, suicide is the fourth leading cause of death among young people aged 15 to 29 years in both sexes (5, 6). Every death due to suicide is a tragedy (7) therefore, paying attention to the causes of suicide and examining its impact from other factors is very important and necessary. Stressful life events, as one of the main risk factors for suicide, are increasing as a global outbreak. One of these stressful events in late 2019 was the outbreak of the new coronavirus (COVID-19), which caused significant stress and social turmoil at the national and global levels, in addition to the casualties caused by the disease (8). In December 2019 and according to the identification of the first case of COVID-19 in Wuhan, China, the World Health Organization announced on January 31, 2020 that the outbreak of this disease was a public health emergency of international concern (9, 10) and took actions such as restricting travel, closing borders, limiting international relations, quarantining, losing jobs, changing lifestyle, increasing deaths and social isolation of the population along with fear and horror of the disease, causing mental problems such as stress, anxiety and depression to increase along with this global pandemic (11, 12). Therefore, COVID-19 is not only an infectious disease with relatively high transmission and mortality (13) but is also considered a serious threat to mental health because social distancing, which was implemented as one of the necessary initial measures to reduce the speed of virus transmission and protect people from COVID-19, could have detrimental secondary effects on unemployment, loneliness and previous mental illnesses of individuals, all of which are known as risk factors for suicide (14). It seems that the side effects of actions that were imposed and implemented by governments to prevent the transmission of new cases of infection caused by COVID-19 (such as social distancing and preventing gatherings) have caused changes in the direction of decreasing or increasing suicide cases (15, 16). According to the comparable estimates of the World Health Organization in 2019, the death rate from suicide in Iranian men and women was 5.2 per 100,000 population, so that this rate was calculated as 4.5 in men and 2.7 per 100,000 population in women (17–19). According to studies that have been performed in Iran and other countries of the world since the beginning of the COVID-19 pandemic, mental illnesses, especially depression, anxiety, and stress, have increased in all groups and occupations (20–25). The primary aim of this study was to examine whether the rise in COVID-19 cases has resulted in an increase or decrease in completed suicides in Iran. To achieve this objective, this objective, the study analyzed the trend of completed suicides across two periods: before and after the World Health Organization declared COVID-19 a mental health emergency impacting human societies. Interrupted Time Series analysis was used to assess its potential effect on suicide statistics within Iran.

Methods

This research was carried out using the framework of ecological studies. The information for the study was obtained and gathered from two main sources:

Records of suicide cases that resulted in death between 2009 and 2023, registered with a suicide diagnosis as the determined cause of death by Iran's Legal Medicine Organization. 2- Essential demographic details and indicators retrieved from the official portal of the Statistical Center of Iran.

After obtaining the study ethics code from the Research Ethics Committee of School of Public Health and Neuroscience Research Center - Shahid Beheshti University of Medical Sciences and presenting it to the Legal Medicine Organization of Iran, the research team received an SPSS file with annual demographic data of individuals who had died by suicide during the study period (2009–2023). The data underwent initial checks for completeness, duplicate removal, and cleaning. Suicides resulting in death were then compiled monthly and annually using Stata software, with categorization based on study variables. Descriptive statistics, incidence rates, and suicide trends were subsequently calculated and analyzed.

Analytical evaluations were performed using the Interrupted Time Series approach, applying segmented regression techniques within R software. This method was chosen because the Interrupted Time Series design is among the most robust quasi-experimental approaches for assessing the effectiveness of health interventions or the impacts of unplanned events and natural occurrence (26), such as the COVID-19 pandemic and etc., which likely influenced community health.

To calculate the age-standardized suicide rate over the 14-year study, the Direct Standardization Method was utilized, based on the World Standard Population framework provided by the World Health Organization for use by countries.

An Excel table containing aggregated data on completed suicides is needed for input into the R software to execute discrete time series commands. This table should consist of seven distinct columns, each described as follows:

The first column represents the year in which suicides resulting in death occurred (Year).

The second column indicates the month of these suicides (Month). Since the study spans 14 years, with each year containing 12 months, this creates 168 rows in which the year is repeated across 14 consecutive years, and the month ranges from 1 to 12, repeated across the 12 months of each year.

The third column is assigned to the outcome variable, which reflects the number of suicides (1). These figures were obtained from the cleaned SPSS dataset and recorded in the Excel spreadsheet, corresponding to the specific month and year of the suicides under examination.

The fourth column encompasses the time variable (Time), used to track changes in the outcome variable over the study period. This variable is numerically coded, starting at 1 for statistics corresponding to April 20, 2009. It progresses sequentially, culminating at 168, denoting March 20, 2023.

The fifth column is designated to the variable "level" in order to analyze changes or interventions, as represented by the term (COVID) in the table. This variable helps to measure the presence or absence of the event under observation by comparing changes in the outcome variable against the counterfactual level. The counterfactual level represents a scenario in which the trend of suicide data is predicted, calculated, and illustrated as though the event under observation—in this case, the COVID-19 pandemic—had not occurred.

In this explanation, the initial data in the "level" column (COVID) corresponds to the period from April 20, 2009, to early May 2020, when the World Health Organization classified the COVID-19 pandemic as a public health emergency affecting human societies (27). During this time frame, the code "zero" represents the absence of the event in question. From that point onward until the conclusion of the study period (March 20, 2023), the code "one" signifies the presence of the event under investigation. Therefore, the first 133 entries have been assigned the code "zero," indicating the event's absence, while the subsequent 35 entries are marked with the code "one," reflecting the event's occurrence.

Column six, the country's population during the years 2009 April-2023 March is shown, which includes the census population or its estimate in the years between the census, which has been extracted from the official website of the Statistical Center of Iran.

The last column, the seventh column, expresses the standardized population of the country. In order to calculate the standard population of the country, the standard population table prepared by the World Health Organization for countries for the years 2005 to 2025 was used, and with the help of the Direct Standardization Method and estimation of the proportions related to each year, the Standardized Population was calculated for each year separately.

An example of the table prepared in the Excel file for recalling the study variables to run the Interrupted Time Series by the segmented regression method in R-Studio software is summarized in Table 1

After preparing the data, it was necessary to pay attention to some points to use the time series method to implement the Interrupted Time Series Method. One of these points was to draw graphs with the help of which many characteristics of the study are detected, such as the presence or absence of trends, seasonal variations, frequencies and unusual (random) variations. By drawing diagrams, it is possible to investigate the autocorrelation and seasonal effect in the residuals of the model (26, 28), because the time variable can distort the results by creating a seasonal effect, so it is necessary to pay attention and adjust it (26).

In the first step, by drawing a distribution graph between the independent and dependent variables, the trend of data occurrence is investigated before the intervention. Because the trend of the data before the intervention indicates the trend of the variable studied over time. Based on the diagram drawn at this stage, it was found that the suicide data in this study have a linear trend with a seasonal effect.

In the second step, a statistical method was selected that showed a change in the effect of the intervention. Since the dependent variable (incidence) was calculated as the number of complete suicides and the nature of the data was discrete enumeration, and due to the over dispersion among the data, the negative binomial regression method was used. In the third step, to investigate the seasonal effect, the residuals of the model and the existence of partial autocorrelation and autocorrelation were drawn, and the examination of the graphs confirmed the seasonal trend in the data, and the harmonic method was used to adjust the seasonal effect. Due to the detailed presentation and review of the harmonic method, it is recommended that the respected readers refer to the following sources [1- Qiang Zhou et al.'s paper titled A novel regression method for harmonic analysis of time series and 2-James

TABLE 1 Sample data set for the study to be called in R-Studio software for discontinuous time series analysis

Year	month	Suicide	time	covid	*pop	*stdpop
20 April 2009	1	257	1	0	**73202**	**79039**
...	...	...	...	0	...	...
2009	**12**	**233**	**12**	0	**73202**	**79039**
...	...	...	...	0	...	...
...	...	...	...	0	...	...
...	...	...	...	0	...	...
2010	12	349	132	0	82710	83718
2020	1	376	133	0	83409	83512
2020	2	438	134	1	83409	83512
...	...	...	...	...	...	...
2020	12	457	144	1	83409	83512
...	...	...	...	...	...	...
...	...	...	...	...	...	...
20 March 2023	12	366	168	1	84700	85334

*Population and standardized population numbers are rounded to the nearest 1,000.

Lopez Bernal et al. (Interrupted Time Series regression for the evaluation of public health interventions: a tutorial)].

In the final step, the changes in the model's slope were examined by analyzing the interaction between time and intervention. Ultimately, the segmented regression model used to evaluate shifts in the level and slope of the annual suicide incidence rate was formulated as follows. Given that the data may involve either a single group or comparisons across several groups, both single-group and multi-group methods can be applied. However, since the analysis in this study was conducted using a single group, the corresponding formula is as follows.

$$Yt = \beta 0 + \beta 1\ T + \beta 2\ Xt + \beta 3\ T\ Xt + \varepsilon\ t$$

Yt is the indicator of the outcome variable at time t after the intervention or nonintervention.

B0 is the baseline level of the outcome variable at time 0 = T (intercept).

B1 is the indicator of the change in the outcome variable for one unit increase in time T (slope of the line before the intervention).

T is the indicator of the time elapsed from the beginning of the study with a unit that indicates the frequency of observations, such as month or year.

B2 is the indicator of the change in the outcome level following the intervention.

Xt is the same binary variable that indicates the intervention or nonintervention of the outcome under study.

B3 is the difference between the slope of the line before and after the intervention.

TXt is the interaction effect of time and intervention, which is also called the slope change after the intervention.

ă t is the model error or random error in time unit (t) (26, 29).

By fitting the Interrupted Time Series regression, the effect of time and intervention (COVID) with the multiplicative effect of time and intervention (interaction effect) were examined. ANOVA was used to compare the related models. The Interrupted Time Series analysis of the data was performed using R software at a significance level of 5 percent.

Results

After extracting the demographic variables of people who died due to suicide from April 2009 to March 2023, it was found that 63,566 cases of suicides leading to death from all over Iran were recorded by the country's forensic medicine, of which 52 cases of suicide were unknown and unrecoverable, which were excluded from the Interrupted Time Series analyses. In order to inform the readers of the article about all the missing cases in the studied variables, their number was included in the demographic and epidemiological tables for the transparency of the researchers' work, but due to the fact that less than 10% of the missing cases in each variable were eliminated during the analysis. As a result, by excluding 52 cases unknown in terms of the month of suicide, the total number of suicides resulting in death in Iran during the 14 years from April 2009 to March 2023 was reported to be 63,514, of which 45,092 (70.9%) were male and 18,473 (29.1%) were female.

TABLE 2 Demographic data of suicide deceased in Iran from April 20, 2009 to March 20, 2023.

Age indicators	Number	Percentage%
Mean	33.9	-
Median	30	-
Mod	20	-
Standard deviation	15.2	-
Age groups		
Less than 10 years	139	0.20%
10–19 years	9,445	14.90%
20–29 years	20,177	31.70%
30–59 years	28,906	45.50%
60 years and more	4,701	7.40%
Unknown	198	0.30%
Gender		
Male	45,092	70.90%
Female	18,473	29.10%
Unknown	1	0.00%
Marital status		
Single	28,408	44.70%
Married	31,607	49.70%
Divorced	2,115	3.30%
Widow	628	1.00%
Unknown	808	1.30%
Education level		
Illiterate, primitive, first high school	19,618	30.90%
Secondary High school, diploma and pre-university	36,438	57.30%
University education (postgraduate, bachelor's degree and above)	6,316	9.90%
Unknown	1,194	1.90%
Job		
Housewife	13,734	21.60%
Worker	6,973	11.00%
Employee, doctor, teacher, judge, professor, psychologist, clergy man, soldier-military	4,446	7.10%
Unemployed	7,933	12.50%
Retired	2056	3.20%
Student, university student	6,337	10.00%
Driver, farmer	3,332	5.20%
Street vendor, smuggler, other	1,012	1.60%
Other self-employed occupations	16,854	26.50%
Unknown, child under 7 years old	889	1.40%

The mean age of those who died by suicide was 33.9 years with 15.2 standard deviations. 77.6% of the patients who died by suicide were in the age group of 20–59 years, of which 45.5% were in the age

TABLE 3 Provincial divisions based on the zoning of the ministry of interior.

Region	Number	Percentage%
Region one: Tehran, Qazvin, Mazandaran, Semnan, Golestan, Alborz and Qom provinces	17,231	27.10%
Region two: Isfahan, Fars, Bushehr, Chaharmahal and Bakhtiari, Hormozgan and Kohgiluyeh and Boyer-Ahmad provinces	11,009	17.30%
Region three: East Azerbaijan, West Azerbaijan, Ardabil, Zanjan, Gilan and Kurdistan provinces.	12,811	20.20%
Region four: Kermanshah, Ilam, Lorestan, Hamedan, Markazi and Khuzestan provinces	15,315	24.10%
Region five: Razavi Khorasan, South Khorasan, North Khorasan, Kerman, Yazd, Sistan and Baluchestan provinces.	7,163	11.30%
Unknown region	37	0.06%
Season		
Spring	16,835	26.50%
Summer	17,571	27.60%
Autumn	14,460	22.70%
Winter	14,648	23.00%
Unknown	52	0.10%

group of 30–59 years. The lowest suicides occurred in the age groups of less than 10 years (0.2%) and over 60 years and older (7.4%), respectively. The suicide rate in men was 2.5 times that of women. However, this ratio has been very close to one in some provinces. In terms of suicide season, 34,406 (54.2%) deaths occurred in spring and summer and 29,108 (45.8%) in autumn and winter.

All the variables studied in this study, including marital status, occupation, education, province of residence of the deceased due to suicide, and the month in which the suicide occurred, were also investigated, and the results of demographic and epidemiological characteristics are summarized in Tables 2, 3, respectively.

The trend of suicides from April 2009–March 2023 showed that the incidence of suicides increased from 4.1 in 2009 to 8.2 per 100,000 population in 2023. This upward trend can be seen in Figure 1.

In the Interrupted Time Series analysis that was adjusted by negative binomial regression and using the harmonic method of season, it was determined that the incidence of suicide increased by 1.003 times per month, and this rate increased by 1.1 times in the presence of COVID-19 disease. The increase in the standardized incidence of suicide increased with increasing time and the presence of the COVID-19 pandemic, and this increase was significant ($p < 0.001$) (Figure 2).

In the study of the interaction effect of time and intervention on the incidence of suicide deaths, it was observed that the interaction effect of COVID and time does not cause a significant change in the graph and the incidence of suicides ($p \geq 0.05$). The comparison of the Akaike criterion between the two models also confirmed the result of the ANOVA test, showing that each of the variables of time and COVID-19 had a positive and significant impact on the increase in standardized suicides, which caused an increase in the level of suicide compared to the time before the COVID-19 pandemic. However, the interaction effect between COVID-19 and time was not significant. The summarized results in Table 4 show this study.

According to Figure 3 and the results of the regression performed, it is observed that the COVID-19 pandemic has only caused an increase in the level of suicide cases (immediate effect) and has not changed the slope of the graph until March 2023.

Discussion

The main focus of the discussion in this study was to investigate the effect of the COVID-19 pandemic on the trend of suicides leading to death before and after the pandemic, and regarding the reasons for the increase or decrease in suicides according to the variables briefly mentioned in the descriptive results, another article is being reviewed and written by the research team, and the discussion about them was avoided.

COVID-19 in Iran started with two deaths on February 19, 2020, and increased to 145,113 cases by March 20, 2023 (30). At the same time, 18,043 cases of suicide deaths were recorded. In May 2020, when the World Health Organization announced that COVID-19, in addition to being an infectious and transmissible disease, is also a mental health emergency, this date was considered the basis for the start of the intervention in this study. The results showed that after three months from the start of the COVID-19 pandemic in Iran, which was equivalent to six months after the presence of the disease in the world, the incidence of suicide deaths throughout the pandemic until the end of 2023, in addition to the increasing trend, changed in the level of suicide incidence. Therefore, the incidence of suicide from May 2020 to March 2023 was accompanied by a 19% increase in suicide, although in the absence of COVID-19, the rate of suicide had an annual increase of 0.3%. Many studies worldwide have examined the effect of COVID-19 on the incidence of mental health diseases, attempted suicide and suicide deaths, and in each country, depending

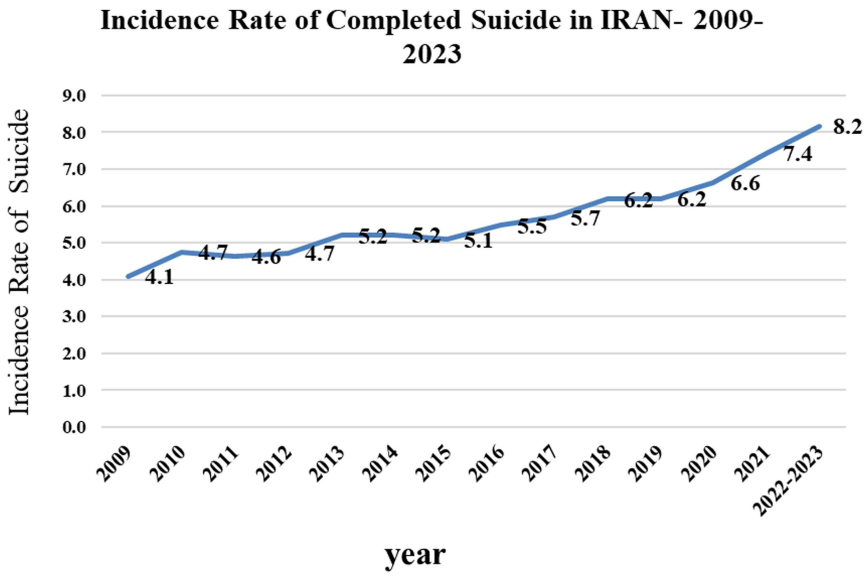

FIGURE 1
Trend of suicide rate leading to death from 2009 to 2011 in IRAN.

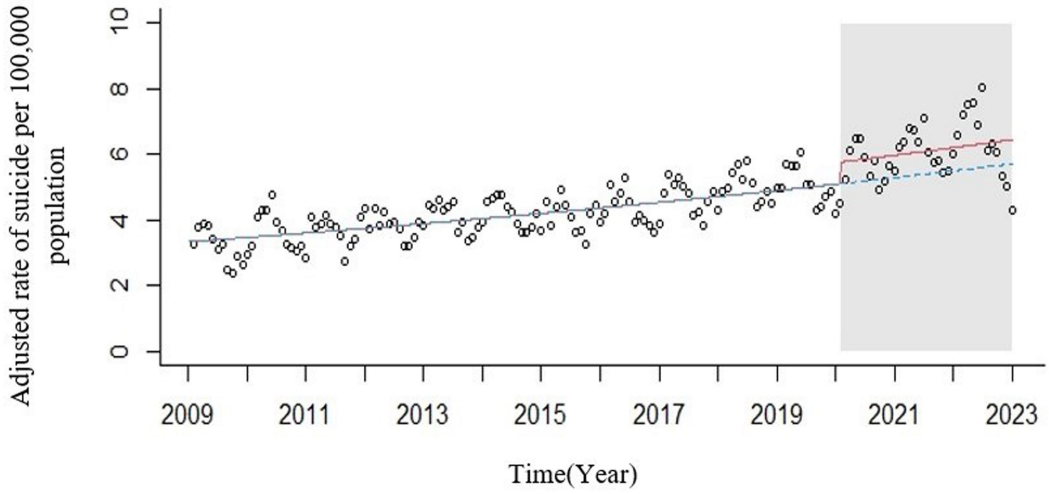

FIGURE 2
ITS plot of standardized incidence of suicide deaths in IRAN from March 2009 to 20,223 compared to the counterfactual level (circles = observed rates; red line = modeled rates fitted to the data; blue line = counterfactual level. Gray area = Announcement of mental health orientation following the COVID-19 pandemic by the WHO).

TABLE 4 **Comparison of implemented models to choose the final model of Interrupted Time Series.**

Model name	Index title	Standardized incidence rate ratio exp (7)	Confidence interval 95% (Confidence interval)	Significance level (*p* value)	Akaike index (AIC)
Model 1 (Time and COVID-19)	Base value (Intercept)	0.003	0.003–0.003	0	1641.696
	Intervention (covid)	1.108	1.003–1.004	0	
	Time (time)	1.003	1.055–1.205	0	
Model 2 (Time and COVID-19 interaction)	Base value (Intercept)	0.003	0.003–0.003	0	1643.329
	Intervention (covid)	0.98	0.662–1.451	0.921	
	Time (time)	1.003	1.003–1.004	0	
	Time Intervention (covid* time)	1.001	0.998–1.003	0.54	

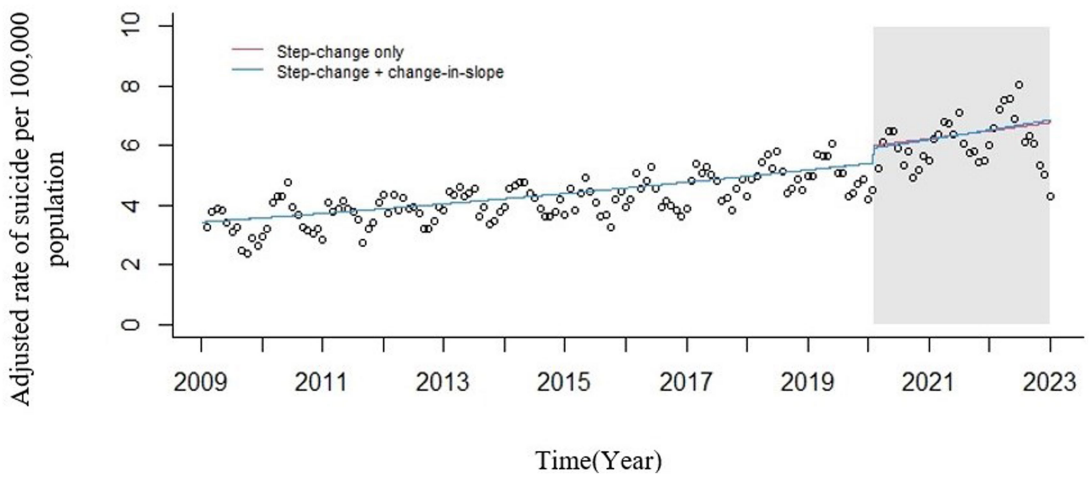

FIGURE 3
Seasonally adjusted ITS plot of standardized incidence of suicide deaths in IRAN from March 2009 to 2023. Circles = observed rates; red line = modeled rates fitted to the data (step change only); blue line = modeled rates fitted to the data (multiplicative interaction). Gray area = Announcement of mental health orientation following the COVID-19 pandemic by the WHO.

on different economic, social and cultural conditions, this effect has been different. For example, in Japan, to examine the social-economic recession and social isolation due to the spread of COVID-19 disease, the expected suicide mortality rate in 2020 was estimated based on suicide mortality from 2011 to 2019 using Join point regression analysis, and after comparing with the actual suicide mortality rates in Japan in 2020, it was observed that the actual suicide mortality in 2020 (one year after the COVID-19 pandemic in the world) was significantly higher than the expected mortality among Japanese men and women (31). Japan was one of the countries that had been relatively successful in controlling the COVID-19 pandemic among Asian countries. When we examine the study by Luo and colleagues on five successful countries in controlling COVID-19 in Asia, one of these countries is Singapore, which was able to control this disease well and accurately by tracing the contacts of people suspected of having the disease (32). To examine the suicide statistics in Singapore, the nonprofit suicide prevention center of this country announced that suicide has been the main cause of death for young people aged 10 to 29 in Singapore for the fourth consecutive year since 2019, and the number of 476 reported suicides in 2022 indicates the highest rate since 2000 in this country and needs to be investigated (33). According to the report of the Centers for Disease Control and Prevention of the United States, the age-adjusted overall suicide rate increased from 10.7 deaths per 100,000 standard population in 2001 to its maximum level of 14.2 in 2018 and then decreased to 13.5 in 2020. However, again in 2021, this rate increased by 4 percent to 14.1 (34). Of course, this study does not mention the effect of COVID-19 on the rate of suicide, but this 4% increase in the occurrence of suicide after the COVID-19 pandemic can be considered for further studies. One study that has examined the impact of COVID-19 on work-related suicides is the thesis of Mona Hassan, who graduated with a master's degree from Washington University in 2023. Her thesis focused on the suicide cases that were related to the workplace during the COVID-19 pandemic using data from the National Violent Death Reporting System (NVDRS) in the United States. She found that COVID-19 potentially highlighted work-related suicides and emphasized the importance of considering demographic factors and conditions in understanding and addressing these incidents (35). As you can see, suicide during the COVID-19 pandemic has been different in different countries, and how many suicides were due to the presence of the COVID-19 pandemic and the specific conditions prevailing in societies during this disease may be more accurately determined in the coming years. However, what has been determined in Iran is that the incidence of suicide in the years after the COVID-19 pandemic has continued to increase with an increasing trend and at a higher level than before the COVID-19 pandemic. It is possible that many factors other than the COVID-19 pandemic influenced the increase in the level of suicide during the post-COVID-19 pandemic period.

The limitations, weaknesses, and strengths of the present study

Among the important limitations and weaknesses that were evident in this study, the following can be mentioned:

Due to the stigma of suicide in many countries, including Iran, there is still the possibility of the survivors of the deceased hiding the cause of death or not cooperating in completing suicide cases. Considering that this study is an ecological study and in recent years, many social, economic, and political events have occurred in Iran whose effects have not been considered in this study, the results should be interpreted more carefully in order to avoid the ecological fallacy bias. Considering that the number of suicide attempts is always several times more than the number of suicides resulting in death, unfortunately, despite correspondence with the relevant organizations in Iran, there was no access to the statistics of suicide attempts, and therefore it was not possible to compare. It is recommended to review and analyze the data and compare the results with other statistical methods such as data analysis and comparison with other statistical methods such as AutoArima in Iran and compare with Iran's neighboring countries.

One of the most important strengths of this study is that all suspicious deaths due to suicide were collected and recorded by the Forensic Medicine Organization, so the data in question were among the most reliable sources of suicide information in Iran.

Conclusion

Suicide rarely occurs as a result of a situation or event. A range of different factors (at individual, relational, societal and environmental levels) can increase the risk. Although this phenomenon is also preventable, it has grown significantly with the gradual progress of societies and the transformation of structures, and despite the attention and efforts of the scientific community, including psychiatrists, sociologists, psychologists and social science counselors, in controlling it, unfortunately, we still witness the occurrence of this bitter and unpleasant phenomenon in many societies, including Iran. In addition to all these cases, unexpected and natural factors that suddenly occur in a society, such as floods, earthquakes, volcanoes, and epidemics such as COVID-19, which caused restrictions in relations and the presence of people in society, can create a favorable environment for people to tend to complete suicide or attempt suicide. Therefore, it is necessary for the economic and health policymakers of the society to take actions to reduce the various effects left over from that crisis during and after any crisis. It is hoped that with regard to the results of this study, which showed an increase in suicides leading to death in the presence of the COVID-19 pandemic and considering the sensitivity and importance of suicide phenomenon in any country, including Iran, the officials and planners of the country who always have the concern of reducing health problems, mortality, mental disorders, and social problems of the people of society can identify provinces with an increasing trend of suicide and provide necessary measures to increase people's access to mental health services. In order to continue the work, it is suggested to investigate the effect of social events in Iran on the phenomenon of suicide in different periods and compare the results with this study.

Data availability statement

The datasets presented in this article are not readily available because the data was received from the legal medicine of Iran, confidentiality and preservation of the data was one of the conditions of the research. Requests to access the datasets should be directed to amahdavi202034@gmail.com.

Ethics statement

The studies involving humans were approved by the Research Ethics Committee of School of Public Health and Neuroscience Research Center-Shahid Beheshti University of Medical Sciences (Ethics ID IR.SMBU.PHNS.REC.1400.052/14 September 2021). The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation was not required from the participants or the participants' legal guardians/next of kin in accordance with the national legislation and institutional requirements.

Author contributions

AN: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. SH: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. MN: Formal analysis, Software, Validation, Visualization, Writing – review & editing. MP: Conceptualization, Writing – review & editing. SM: Data curation, Resources, Writing – review & editing. AK: Investigation, Resources, Writing – review & editing.

Funding

The author(s) declare that no financial support was received for the research, authorship, and/or publication of this article.

Acknowledgments

The present article was extracted from the Master's thesis of epidemiology of the School of Public Health and Safety of Shahid Beheshti University of Medical Sciences, which was carried out with the assistance of the Research and Iranian Legal Medicine Organization, with the permission to access the data of suicides leading to death in the country from 2009 to 2023. Therefore, we are grateful to all who helped us to conduct this research. Artificial intelligence was not used in the presentation of any part of the article, only to translate the text from the authors' original language, which is Persian, and must be translated into English for presentation in reputable foreign journals. In light of a comment from one of the journal's respected reviewers, Monica's artificial intelligence and ChatGPT were used to review sentences and texts in some sections related to the method.

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

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frontiers | Frontiers in Public Health

TYPE Original Research
PUBLISHED 26 March 2025
DOI 10.3389/fpubh.2025.1406062

OPEN ACCESS

EDITED BY
Gabriele Nibbio,
University of Brescia, Italy

REVIEWED BY
Gabriele d'Ettorre,
ASL Lecce, Italy
Mustafa Kursat Sahin,
Ondokuz Mayıs University, Türkiye
Shujing Zhang,
Emory University, United States

*CORRESPONDENCE
Jimin Fan
✉ fanjim@fyey.cn
Yixiang Zhang
✉ yx_zhang@fjmu.edu.cn

†These authors have contributed equally to this work

RECEIVED 24 March 2024
ACCEPTED 05 March 2025
PUBLISHED 26 March 2025

CITATION
Huang S, Chen Q, Qiu S, Dai R, Yao L, Zhuang J, Wu Z, Zeng Y, Fan J and Zhang Y (2025) Prediction models for sleep quality among frontline medical personnel during the COVID-19 pandemic: cross-sectional study based on internet new media.
Front. Public Health 13:1406062.
doi: 10.3389/fpubh.2025.1406062

Prediction models for sleep quality among frontline medical personnel during the COVID-19 pandemic: cross-sectional study based on internet new media

Shangbin Huang[1†], Qingquan Chen[1,2†], Shengxun Qiu[3†], Rongrong Dai[2], Ling Yao[3], Jiajing Zhuang[3], Zhijie Wu[3], Yifu Zeng[4], Jimin Fan[1*] and Yixiang Zhang[1*]

[1]The Second Affiliated Hospital of Fujian Medical University, Quanzhou, China, [2]The School of Public Health, Fujian Medical University, Fuzhou, China, [3]The School of Clinical Medicine, Fujian Medical University, Fuzhou, China, [4]Cyberspace Institute of Advanced Technology, Guangzhou University, Guangzhou, China

Background: The factors associated with sleep quality among medical personnel providing support on the frontline during the height of the COVID-19 pandemic remain unclear, and appropriate predictive and screening tools are lacking. This study was designed and conducted to investigate whether factors such as weight change, job title, and tea consumption influence the sleep quality of these workers. Additionally, the study aims to develop predictive models to analyze the sleep problems experienced by healthcare workers during periods of epidemic instability, and to provide relevant data and tools to support effective intervention and prevention strategies.

Methods: A cross-sectional study was conducted from June 25 to July 14, 2022, using a self-administered general information questionnaire and the Pittsburgh Sleep Quality Index (PSQI) to investigate the sleep quality of medical personnel providing aid in Shanghai. The relevant influencing factors were obtained via univariate analysis and multivariate stepwise logistic regression analysis, and 80% of the data were used in the training-test set (n = 1,060) and 20% were used in the independent validation set (n = 266). We used snowball sampling to establish the six models of logistics (LG), deep learning (DL), naïve Bayes (NB), artificial neural networks (ANN), random forest (RF), and gradient-boosted trees (GBT) and perform model testing.

Results: Among the participants, 75.8% were female. Those under 35 years of age comprised 53.7% of the medical staff, while those over 35 years accounted for 46.3%. The educational background of the participants included 402 individuals with an associate degree (30.3%), 713 with a bachelor's degree (53.8%), and 211 with a master's degree or higher (15.9%).Weight, job title, and tea consumption during the aid period were the main factors influencing the sleep quality of medical personnel during the aid period. The areas under the curve (AUC) of LG, DL, NB, ANN, RF, and GBT were 0.645, 0.656, 0.626, 0.640, 0.551, and 0.582, respectively. The DL model has the best prediction performance (specificity = 86.1%, sensitivity = 45.5%) of all the models.

Conclusion: During the height of the COVID-19 pandemic, the sleep quality of frontline medical personnel providing aid in Shanghai was influenced by multiple

factors, and the DL model was found to have the strongest overall predictive efficacy for sleep quality.

KEYWORDS

sleep quality, medical personnel, COVID-19, machine learning sleep quality, deep learning

1 Introduction

In February 2022, a COVID-19 outbreak occurred in Shanghai, and as of April 29, more than 50,000 local cases of novel coronavirus pneumonia were confirmed. From April 2022 to June 2022, frontline medical teams from Fujian Province assisted Shanghai in the fighting against the new coronavirus pneumonia, taking over several square-cabin hospitals in Shanghai to provide assistance in the treatment of the outbreak.

During the COVID-19 pandemic, the general population experienced increased psychological symptoms, including stress, depression, and anxiety, which negatively impacted sleep quality (1–3). Healthcare workers were particularly affected, with many reporting anxiety, depression, and insomnia. Studies showed that sleep problems were closely linked to these psychological issues, with healthcare workers experiencing higher rates of sleep disturbances and even PTSD compared to other professions (4–6). Increased exposure to COVID-19 risks contributed to greater psychological burdens for healthcare workers, leading to higher levels of self-reported anxiety and depression (7, 8). Poor sleep quality negatively affects both the physical and mental health of medical personnel, and it has been linked to increased safety risks (9, 10). For clinical staff, adequate sleep is crucial for maintaining optimal health, performance, and immune function (11). However, sleep and psychological issues among healthcare workers have not been adequately addressed, despite the severe impact of the pandemic on their well-being (12).

The pandemic overwhelmed healthcare systems, highlighting the need for targeted stress management and social support interventions for healthcare workers (13). Improving sleep quality through scientific and targeted management tools is essential to support healthcare workers' physical and mental health, enabling them to better cope with the challenges of frontline work (31).

Machine learning (ML) and artificial intelligence (AI) have shown promise in healthcare, particularly in developing predictive models for sleep quality. These models have been successfully applied in areas such as sleep staging and sleep quality prediction during the COVID-19 pandemic (14–16). Machine learning, including predictive models based on short sleep questionnaires, has demonstrated potential for accurately identifying sleep disturbances, offering insights that could improve sleep health for healthcare workers (17). Thus, machine learning can be utilized to predict sleep problems, enhance our understanding of the sleep issues healthcare workers may face, and provide a solid foundation for effective solutions.

Previous studies have examined factors affecting the sleep quality of medical personnel during the COVID-19 pandemic. However, due to the varied working conditions, no studies have developed or validated sleep quality prediction models specifically for frontline medical personnel on assignment. Exploring the predictors of sleep quality affecting frontline medical personnel on assignment support and developing and validating sleep quality prediction models using machine learning methods such as LG, DL, NB, ANN, RF and GBT would be beneficial to help address the above issues.

This study was designed and conducted to investigate the sleep quality of frontline healthcare workers and the factors influencing it in the context of the fight against novel coronavirus pneumonia in Shanghai. Additionally, the study sought to develop a predictive model to better understand the sleep problems these healthcare workers may encounter during volatile public health outbreaks, providing relevant data and tools to support effective intervention and prevention strategies.

2 Methods

2.1 Study design

This cross-sectional study was conducted using a snowball sampling method to select 2024 administrators, nurses, clinicians, and other (medical technology, pharmacy, and testing) personnel who were part of the frontline medical workforce fighting novel coronavirus pneumonia in Shanghai from April 2022 to June 2022. The inclusion criteria included: 1. being administrative, nurses, clinicians, and other (medical, pharmacy, and laboratory) personnel who participated in front-line medical work against novel coronavirus pneumonia; 2. performing frontline clinical work for ≥1 week; 3. being located in various cities in Fujian Province; and 4. finishing the questionnaire within 10 min. The exclusion criteria included: 1. being non-working medical personnel; 2. not being from Fujian; 3. questionnaire filling time too short (<100 s) or too long (>10 min); and 4. questionnaire answers were obviously abnormal (age filled in 10 years old).We excluded a total of 698 respondents, and 1,326 respondents were ultimately included in the analysis.

2.2 Data collection

A questionnaire was dropped to the respondents via social media, including general information about the study participants and The Pittsburgh Sleep Quality Index (PSQI). The questionnaires were collected during the isolation period following the medical staff's return from Shanghai to Fujian. The purpose of the survey and the requirements for completing the questionnaire were stated at the beginning of the questionnaire. After the questionnaires were collected, they were manually checked and invalid questionnaires were excluded.

2.3 Observation indicators

(1) The general information questionnaire included age, gender, address, marital status, education, title, type of work, length of service, and other basic information.

(2) Sleep status scale (last month): The Pittsburgh Sleep Quality Index (PSQI) was developed by Dr. Buysse, a psychiatrist at the University of Pittsburgh, in 1989 to assess overall sleep quality in seven areas: subjective sleep quality, sleep onset latency, sleep duration, sleep efficiency, sleep disturbances, use of sleep medications, daytime dysfunction, and global PSQI score. When the PSQI score is higher than 5, this indicates that there is a problem with sleep quality, and the higher the score, the worse the sleep quality. The higher the score, the worse the sleep quality. When the subject scored >1 on 7 aspects of the PSQI scale (subjective sleep quality, sleep onset latency, sleep duration, sleep efficiency, sleep disorder, hypnotic medication, and daytime dysfunction), it indicated a sleep problem.

2.4 Data analysis

The count data were expressed as frequencies and percentages, and the measurement data were expressed as means ± standard deviations ($x \pm s$). A chi-square test (χ^2) was used and the correlations of all variables were determined using Pearson correlation coefficients. The factors influencing sleep quality were analyzed using a one-way analysis of variance and multiple stepwise logistic regression. The OR values and 95% confidence intervals were calculated, and p values<0.05 were considered statistically significant (2-sided test). R (4.2.0) statistical software was used for data analysis.

2.5 Model building

The data were preprocessed for data normalization (including sample scale normalization, sample-by-sample mean subtraction, and normalization) and data whitening. Afterward, we performed data visualization and eigenvalue engineering on the data. Six models were built using LG, DL, NB, ANN, RF, and GBT. The six algorithms applied in this study are widely used supervised learning techniques capable of handling both numerical and categorical features. These models have a solid research foundation in the field of sleep problem prediction. Additionally, these models are well-known to users, which facilitates their adoption, application, and future customization upgrades. All models were trained using weight change, professional job titles, tea drinking during assistance to predict the sleep problems faced by these healthcare workers. The included data were randomly divided into a training-test set (80%, n = 1,060) and an independent validation set (20%, n = 266). To avoid overftting and improve the model, we used 10-fold cross-validation in the training-test set. In this process, all the data is divided into 10 parts and then each part is used as a validation set and the other parts are used as a training set for training and validation, which is repeated 10 times each time using a different validation set.

Samples from these six models were used in the training-test set as well as the independent validation set to test the model with the seven metrics of AUC, accuracy, sensitivity, specificity, precision, F1-score, and KAPPA. The area under the curve (AUC) values of the six models were then evaluated. The higher AUC closer to 1 indicates better performance.

2.6 Ethical review

This questionnaire was approved by the Medical Ethics Committee of the Second Affiliated Hospital of Fujian Medical University (IRB No. 2021–309), and all respondents were aware of and agreed to participate in this survey.

3 Results

3.1 Demographic characteristics

Participants were aged 23–58, mostly female, from Fuzhou, Xiamen, Zhangzhou, married, in medical/nursing roles, with undergraduate/college degrees, over 3 years of work (most >10 years), and mostly held various job titles: junior (50.2%), mid-level (32.0%) (Table 1).

3.2 Some characteristics of the situation before participating in the aid process

The chi-square test showed that some of the medical personnel's previous condition characteristics such as BMI, dietary pattern, exercise routine, alcohol consumption, sun exposure, tea drinking, smoking, and underlying diseases were not statistically significant in association with sleep quality before participating in the aid process (Table 2).

3.3 Comparison of scores on seven components of the PSQI among medical personnel with different working ages

There was no statistical significance in scores between the different working age groups except in terms of sleep efficiency and the use of sleep medications (p = 0.054 and 0.384, respectively). The 0–2 years working age group had the best sleep quality (1.35 ± 0.92), sleep onset latency (1.57 ± 1.17), sleep duration (1.35 ± 0.94), and sleep disturbances (1.30 ± 0.93) and the lowest Global PSQI score (9.64 ± 4.67), which indicates that those with 0–2 years of service had the best subjective sleep quality, the shortest time to fall asleep, the longest sleep duration, and the least sleep disturbances. Those with >10 years of service had the worst subjective sleep quality and the shortest sleep duration. The final PSQI total score shows that the overall quality of sleep was better for those with 0–2 years of service (9.64 ± 4.67), while the Global PSQI score was worse for those with 6–10 years of service (11.72 ± 3.87), reflected in the lowest scores for time to fall asleep, sleep disturbances, and daytime dysfunction (Table 3).

3.4 Comparison of scores on seven components of the PSQI among medical personnel with different education levels

There was no statistically significant relationship with sleep quality among people with different education levels in terms of

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TABLE 1 Demographic characteristics of the respondents in this survey (N = 1,326).

Characteristic	Contents	Participants, n (%)
Age	<35	712 (53.7)
	≥35	614 (46.3)
Gender	Male	321 (24.2)
	Female	1,005 (75.8)
Residence	Fuzhou	574 (43.3)
	Longyan	22 (1.7)
	Nanping	68 (5.1)
	Ningde	67 (5.1)
	Putian	88 (6.6)
	Quanzhou	72 (5.4)
	Sanming	70 (5.3)
	Xiamen	249 (18.8)
	Zhangzhou	116 (8.7)
Marital status	Unmarried	467 (35.2)
	Married	820 (61.8)
	Widowed	36 (2.7)
	Divorced	3 (0.2)
Education	Associate degree	402 (30.3)
	Bachelor's degree	713 (53.8)
	Master's degree and above	211 (15.9)
Professional job titles	None	39 (2.9)
	Junior	665 (50.2)
	Mid-level	424 (32.0)
	Deputy senior	166 (12.5)
	Senior	32 (2.4)
Type of work	Administrative personnel	34 (2.6)
	Nurse	911 (68.7)
	Doctor	289 (21.8)
	Medical technician	92(6.9)
Length of job (years)	0~2	113 (8.5)
	3~5	260 (19.6)
	6~10	347 (26.2)
	>10	606 (45.7)

sleep duration (p = 0.746), use of sleep medications (p = 0.242), and Global PSQI score (p = 0.286). Those with college degrees had the lowest scores in the three aspects of sleep efficiency (1.59 ± 1.08), sleep disturbances (1.54 ± 0.75), and daytime dysfunction (1.66 ± 0.91) while having the highest scores in the two aspects of subjective sleep quality (1.85 ± 0.83) and sleep onset latency (2.13 ± 0.91), implying that those with college degrees had the highest sleep efficiency, encountered the least sleep disturbances, and had the least daytime dysfunction but had the worst subjective sleep quality and the longest sleep time; those with a bachelor's degree had the best subjective sleep quality (1.60 ± 0.88); those with master's degree and above had the shortest sleep time (1.87 ± 1.07) but the lowest sleep efficiency (1.82 ± 1.12) and also encountered sleep disturbances (1.70 ± 0.91) and daytime dysfunction (2.02 ± 1.03) the most frequently (Table 4).

3.5 Comparison of the detection rate of seven sleep problems in working hours over 8 h per day

The detection rates of all seven sleep problems were statistically different between those who worked more than 8 h per day compared to those who worked less than 8 h per day. Among the seven sleep problems, the greatest difference in the detection rate of sleep onset disorder [499 (72.5%)] was encountered in the population working more than 8 h per day compared to those working less than 8 h per day, followed by daytime dysfunction [462 (67.2%)] and subjective sleep quality [458 (66.6%)]. Only in the case of hypnotic drug use was the score of the population working less than 8 h per day higher than that of the population working more than 8 h. The comparison of the detection rates of the seven sleep problems in the case of working more than 8 h per day is shown in Table 5.

3.6 Univariate analysis of factors affecting sleep quality

The univariate analysis showed that gender, education, weight change, type of work, job title, length of service, substance use during assistance, position support, and tea drinking during assistance were statistically associated with sleep quality (all $p < 0.05$). Sleep quality was poorer among those who were female, had a university degree, lost weight, were doctors, had a junior title, had more than 10 years of work experience, and drank tea during assistance. However, the use of drugs during assistance had little effect on the quality of sleep. The sleep quality was generally poorer among those in any support positions (Table 6).

3.7 Multi-factor analysis of factors influencing sleep quality in medical personnel

The factors with $p < 0.10$ in the univariate analysis, gender, education, weight change, job type, job title, length of service, marital status, drug use during assistance, position support, tea drinking during assistance, and underlying disease status, were included in the multiple stepwise logistic regression analysis. The seven factors of gender, weight change, job type, job title, support position, tea consumption during assistance, and underlying disease were further analyzed according to AIC, and the results show that weight change, job title, and tea consumption during assistance are the main predictors of sleep quality among medical personnel during assistance, with statistically significant differences ($p < 0.05$) (Table 7). Further regression analysis of these three showed that the factors of no change in weight or weight gain were favorable to sleep quality, while having junior, intermediate, associate, and senior titles and drinking tea during assistance were all risk factors for sleep quality, with deputy senior (OR 9.1, 95% CI 3.1–28.0) in particular having the greatest impact on sleep quality (Figure 1).

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TABLE 2 Some characteristics of the situation before participating in the rescue.

Variables	*N* = 1,326	Sleep quality		Univariate analysis		
		Good (PSQI scores≤5)	Poor (PSQI scores>5)	χ^2	Degrees of freedom	*p*
BMI before assistance						
18.5 kg/m²	145	14(13.0)	131(10.8)	0.537	3	0.911
18.5~23.9 kg/m²	878	70(64.8)	808(66.3)			
24.0~27.9 kg/m²	261	21(19.4)	240(19.7)			
≥28.0 kg/m²	42	3(2.8)	39(3.2)			
Meal regularity before assistance						
No	953	85(78.7)	868(71.3)	2.360	1	0.124
Yes	373	23(21.3)	350(28.7)			
Daily exercise duration						
<30 min/day	611	41(38.0)	570(46.8)	3.235	2	0.198
30~60 min/day	545	50(46.3)	495(40.6)			
>60 min/day	170	17(15.7)	153(12.6)			
Drinking before assistance						
No	909	73(67.6)	836(68.6)	4.601	3	0.203
<15 g/day	352	29(26.9)	323(26.5)			
15~25 g/day	45	2(1.9)	43(3.5)			
>25 g/day	20	4(3.7)	16(1.3)			
Sun exposure before assistance						
No	715	66(61.1)	649(53.3)	3.352	2	0.187
<30 min/day	380	23(21.3)	357(29.3)			
≥30 min/day	231	19(17.6)	212(17.4)			
Tea drinking before assistance						
No	514	50(46.3)	464(38.1)	2.861	3	0.414
Occasionally (1~2/week)	535	38(35.2)	497(40.8)			
Frequently (3~5/week)	200	14(13.0)	186(15.3)			
Every day	77	6(5.6)	71(5.8)			
Smoking before assistance						
No	1,205	105(97.2)	1,100(90.3)	5.904	3	0.116
<5 cigarettes/day	85	2(1.9)	83(6.8)			
5~10 cigarettes/day	24	1(0.9)	23(1.9)			
>10 cigarettes/day	12	0(0.0)	12(1.0)			
Basic diseases						
No	1,175	102(94.4)	1,073(88.1)	8.140	7	0.320
Diabetes	15	0(0.0)	15(1.2)			
Chronic kidney disease	6	0(0.0)	6(0.5)			
Coronary heart disease	2	0(0.0)	2(0.2)			
Hyperlipidemia	21	1(0.9)	20(1.6)			
Hypertension	36	2(1.9)	34(2.8)			
Malignant tumors	3	1(0.9)	2(0.2)			
Other	68	2(1.9)	66(5.4)			

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TABLE 3 Comparison of scores on seven components of the PSQI among medical personnel with different lengths of job in this survey ($\overline{x}$±S).

	Subjective sleep quality	Sleep onset latency	Sleep duration	Sleep efficiency	Sleep disturbances	Use of sleep medications	Daytime dysfunction	Global PSQI score
0~2	1.35 ± 0.92	1.57 ± 1.17	1.35 ± 0.94	1.89 ± 1.11	1.30 ± 0.93	0.71 ± 1.00	1.48 ± 1.10	9.64 ± 4.67
3~5	1.61 ± 0.88	1.95 ± 0.98	1.65 ± 0.89	1.74 ± 1.17	1.53 ± 0.82	0.91 ± 1.15	1.73 ± 1.02	11.12 ± 4.13
6~10	1.72 ± 0.85	2.08 ± 0.93	1.68 ± 0.88	1.79 ± 1.11	1.66 ± 0.78	0.98 ± 1.11	1.82 ± 0.93	11.72 ± 3.87
>10	1.79 ± 0.89	2.01 ± 0.98	1.83 ± 0.88	1.67 ± 1.07	1.59 ± 0.81	0.89 ± 1.10	1.78 ± 0.99	11.56 ± 3.92
The global score	1.70 ± 0.89	1.98 ± 0.99	1.71 ± 0.90	1.73 ± 1.11	1.57 ± 0.82	0.90 ± 1.10	1.76 ± 0.99	11.35 ± 4.05
F	25.100	11.220	27.670	3.730	8.153	0.758	5.917	15.67
P	<0.001	<0.001	<0.001	0.054	0.004	0.384	0.015	<0.001

Compared with 0~2.

TABLE 4 Comparison of scores on seven components of the PSQI among medical personnel with different educational backgrounds in this survey ($\overline{x}$ ±S).

	Subjective sleep quality	Sleep onset latency	Sleep duration	Sleep efficiency	Sleep disturbances	Use of sleep medications	Daytime dysfunction	Global PSQI score
Associate degree	1.85 ± 0.83	2.13 ± 0.91	1.77 ± 0.87	1.59 ± 1.08	1.54 ± 0.75	0.95 ± 1.12	1.66 ± 0.91	11.48 ± 3.73
Bachelor's degree	1.60 ± 0.88	1.93 ± 1.00	1.65 ± 0.90	1.79 ± 1.11	1.55 ± 0.82	0.80 ± 1.04	1.73 ± 1.01	11.06 ± 4.03
Master's degree and above	1.74 ± 0.96	1.87 ± 1.07	1.80 ± 0.91	1.82 ± 1.12	1.70 ± 0.91	1.14 ± 1.24	2.02 ± 1.03	12.10 ± 4.59
The global score	1.70 ± 0.89	1.98 ± 0.99	1.71 ± 0.90	1.73 ± 1.11	1.57 ± 0.82	0.90 ± 1.10	1.76 ± 0.99	11.35 ± 4.05
F	5.558	12.120	105.000	8.597	4.361	1.371	15.61	1.138
P	0.019	<0.001	0.746	0.003	0.037	0.242	<0.001	0.286

Compared with associate degree.

TABLE 5 Comparison of the detection rate of 7 sleep problems for those working over 8 h daily in this survey [n (%)].

Variables	Subjective sleep quality	Sleep onset latency	Sleep duration	Sleep efficiency	Sleep disturbances	Use of sleep medications	Daytime dysfunction
Working hours ≤8	230(33.4)	189(27.5)	282(41.0)	299(43.5)	306(44.5)	415(60.3)	226(32.8)
Working hours >8	458(66.6)	499(72.5)	406(59.0)	389(56.5)	382(55.5)	273(39.7)	462(67.2)
df	1	1	1	1	1	1	1
χ^2	17.383	6.217	15.845	7.535	27.926	49.038	22.341
P	<0.001	0.013	<0.001	0.006	<0.001	<0.001	<0.001

Each PSQI component score > 1 point indicates a sleep problem.

3.8 Performance of prediction model

Following sufficient training, the six models were utilized on the validation set. The hyperparameters for the all six models are provided in Supplementary Table 1. The seven metrics of AUROC, accuracy, sensitivity, specificity, precision, F1-score, and KAPPA of the tested models were used to perform the testing of the six models LG, DL, NB, ANN, RF, and GBT. The ROC curves of the six models are analytically evaluated as follows (Figure 2), where LG: AUC = 0.645 (0.508–0.781), DL: AUC = 0.656 (0.521–0.792), NB: AUC = 0.626 (0.491–0.761), ANN: AUC = 0.640 (0.503–0.777), RF: AUC = 0.551 (0.383–0.719), and GBT: AUC = 0.582

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TABLE 6 Univariate analysis of factors affecting sleep quality [number] among medical personnel in this survey.

Variables	*N* = 1,326	Sleep Quality		Univariate analysis		
		Good (PSQI scores≤5)	Poor (PSQI scores>5)	χ^2	Degrees of freedom	*p*
Age						
<35	712	66(61.1)	646(53.0)	2.286	1	0.131
≥35	614	42(38.9)	572(47.0)			
Gender						
Male	321	40(37.0)	281(23.1)	9.799	1	0.002
Female	1,005	68(63.0)	937(76.9)			
Education						
Associate degree	402	21(19.4)	381(31.3)	6.684	2	0.035
Bachelor's degree	713	66(61.1)	647(53.1)			
Master's degree and above	211	21(19.4)	190(15.6)			
BMI during assistance						
18.5 kg/m^2	252	15(13.9)	237(19.5)	2.781	3	0.427
18.5 ~ 23.9 kg/m^2	874	76(70.4)	798(65.5)			
24.0 ~ 27.9 kg/m^2	175	16(14.8)	159(13.1)			
≥28.0 kg/m^2	25	1(0.9)	24(2.0)			
Weight change						
Lighten	1,056	64(59.3)	992(81.4)	32.372	2	<0.001
No	203	36(33.3)	167(13.7)			
Heavier	67	8(7.4)	59(4.8)			
Type of work						
Administrative personnel	34	0(0.0)	34(2.8)	45.290	3	<0.001
Nurse	92	23(21.3)	69(5.7)			
Doctor	911	55(50.9)	856(70.3)			
Medical technician	289	30(27.8)	259(21.3)			
Professional job titles						
None	39	11(10.2)	28(2.3)	23.802	4	<0.001
Junior	665	55(50.9)	610(50.1)			
Mid-level	424	32(29.6)	392(32.2)			
Deputy senior	166	8(7.4)	158(13.0)			
Senior	32	2(1.9)	30(2.5)			
Length of job (years)						
0~2	113	27(25.0)	86(7.1)	44.060	3	<0.001
3~5	260	23(21.3)	237(19.5)			
6~10	347	17(15.7)	330(27.1)			
>10	606	41(38.0)	565(46.4)			
Marital status						
Unmarried	467	50(46.3)	417(34.2)	6.629	3	0.085
Married	820	55(50.9)	765(62.8)			
Widowed	36	3(2.8)	33(2.7)			
Divorced	3	0(0.0)	3(0.2)			
Medical assistance history						
No	638	66(61.1)	572(47.0)	7.399	1	0.007
Yes	688	42(38.9)	646(53.0)			

(Continued)

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TABLE 6 (Continued)

Variables	*N* = 1,326	Sleep Quality		Univariate analysis		
		Good (PSQI scores≤5)	Poor (PSQI scores>5)	χ^2	Degrees of freedom	*p*
Support positions						
Designated hospital general ward	348	24(22.2)	324(26.6)	14.965	4	0.005
Fever clinics	343	43(39.8)	300(24.6)			
Designated hospital ICU	32	3(2.8)	29(2.4)			
Nucleic acid sampling and detection	308	14(13.0)	294(24.1)			
Other	295	24(22.2)	271(22.2)			
Work shift						
Day shift	448	40(37.0)	408(33.5)	0.674	2	0.714
Night shift	32	3(2.8)	29(2.4)			
Change shifts	846	65(60.2)	781(64.1)			
Daily working hours in contaminated areas						
≤8	1,258	105(97.2)	1,153(94.7)	0.861	1	0.353
>8	68	3(2.8)	65(5.3)			
Days off per week						
≤2	1,283	104(96.3)	1,179(96.8)	<0.001	1	1.000
>2	43	4(3.7)	39(3.2)			
Tea drinking during assistance						
No	612	66(61.1)	546(44.8)	10.654	3	0.014
Occasionally (1-2/week)	431	25(23.1)	406(33.3)			
Frequently (3-5/week)	191	12(11.1)	179(14.7)			
Every day	92	5(4.6)	87(7.1)			
Smoking during assistance						
No	1,210	103(95.4)	1,107(90.9)	4.977	3	0.174
<5 cigarettes/day	73	2(1.9)	71(5.8)			
5~10 cigarettes/day	26	3(2.8)	23(1.9)			
>10 cigarettes/day	17	0(0.0)	17(1.4)			
Basic diseases						
No	1,175	102(94.4)	1,073(88.1)	3.359	1	0.067
Yes	151	6(5.6)	145(11.9)			
Frequency of contacting COVID-19 patients						
Every day	186	15(13.9)	171(14.0)	3.495	2	0.174
Every few days	277	30(27.8)	247(20.3)			
No contact	863	63(58.3)	800(65.7)			

(0.420–0.744). It can be seen that the DL model has the largest AUC, so the DL model performed best with the following specific indicators: AUROC (95% CI): 0.656 (0.521–0.792), accuracy (95% CI): 0.827 (0.828–0.826), sensitivity (95% CI): 0.455 (0.663–0.246), specificity (95% CI): 0.861 (0.904–0.817), precision (95% CI): 0.227 (0.351–0.103), F1-score (95% CI): 0.303 (0.459–0.145), and KAPPA (95% CI): 0.217 (0.368–0.065) (Table 8). The DL model has the highest AUC value (0.656), but its low sensitivity (45.5%) limits its application in screening and makes it more suitable for confirming positive cases, especially in scenarios that require high specificity (Table 8).

4 Discussion

4.1 Main results

Our results show that the sleep quality of medical personnel providing aid in Shanghai during the epidemic was influenced by factors such as weight change, job title, and tea consumption during the aid period. After model building, training, and validation, the DL model has the best performance for predicting the sleep quality of frontline medical personnel in outstation support. This model may assist in identifying individuals at risk of poor sleep quality. This study

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TABLE 7 Results of the multivariate stepwise logistic regression analysis of factors related to sleep quality among medical personnel in this survey.

Predictor	OR	95% CI	*p*
Gender			
Male	1.00		
Female	1.78	0.99–3.19	0.054
Weight change			
Lighten	1.00		
No	0.33	0.20–0.54	<0.001
Heavier	0.44	0.20–1.05	0.045
Type of work			
Administrative personnel	1.00		
Nurse	0.00	0.00–0.00	0.979
Doctor	0.00	0.00–6681782.21	0.981
Medical technician	0.00	0.00–0.00	0.980
Professional job titles			
None	1.00		
Junior	4.83	1.93–11.60	<0.001
Mid-level	4.90	1.94–11.87	<0.001
Deputy senior	9.10	3.07–28.04	<0.001
Senior	4.43	0.93–32.77	0.087
Support positions			
Designated hospital general ward	1.00		
Fever clinics	0.60	0.33–1.07	0.087
Designated hospital ICU	0.90	0.25–4.64	0.889
Nucleic acid sampling and detection	2.09	1.01–4.52	0.051
Other	0.79	0.42–1.48	0.462
Tea drinking during assistance			
No	1.00		
Occasionally (1–2/week)	1.93	1.17–3.28	0.012
Frequently (3–5/week)	1.79	0.92–3.76	0.101
Every day	1.82	0.73–5.58	0.237
Basic diseases			
No	1.00		
Yes	2.33	1.01–6.40	0.069

reveals that healthcare workers with fewer working years exhibit better sleep quality than their more experienced counterparts ($p < 0.05$), likely attributable to cumulative work-related stress and age-related physiological decline. Assessments of interpersonal and psychological stress responses showed higher scores among senior staff, indicating intensified interpersonal challenges and reduced stress tolerance with prolonged tenure. Notably, all participants displayed elevated PSQI scores (>11), underscoring the pervasiveness of sleep disturbances in this population. Additionally, individuals with undergraduate degrees had the best sleep quality, possibly because they worked in less stressful environments and had more psychological relief than those with postgraduate degrees.

In this study, the sleep quality of medical staff working more than 8 h a day was significantly lower than that of those working 8 h or less ($p < 0.05$), indicating that extended working hours negatively impact sleep quality. The data suggest that continuous overload can lead to burnout (18), which may create a bidirectional relationship (19) through psychological changes such as anxiety and depression. It is noteworthy that during the medical team's deployment in Shanghai, task intensity increased sharply, and the average daily working hours were significantly longer than those typically encountered in their regular duties. This aligns with the findings of a cross-sectional study involving 1,510 male white-collar workers, which confirmed a dose–response relationship between working hours and the risk of sleep disorders (20). Existing evidence indicates that this vicious cycle ultimately compromises mental health and consistently reduces sleep quality (21, 22).

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Feature Variables	Good(≤5)	Poor(>5)	Odds Ratios (95% CI)
Weight change			
Lighten	64	992	1.0 (1.0 to 1.0)
No	36	167	0.3 (0.2 to 0.5)
Heavier	8	59	0.4 (0.2 to 1.1)
Professional job titles			
None	11	28	1.0 (1.0 to 1.0)
Junior	55	610	4.8 (1.9 to 11.6)
Mid-level	32	392	4.9 (1.9 to 11.9)
Deputy senior	8	158	9.1 (3.1 to 28.0)
Senior	2	30	4.4 (0.9 to 32.8)
Tea drinking during assistance			
No	66	546	1.0 (1.0 to 1.0)
Occasionally (1-2/week)	25	406	1.9 (1.2 to 3.3)
Frequently (3-5/week)	12	179	1.8 (0.9 to 3.8)
Every day	5	87	1.8 (0.7 to 5.6)

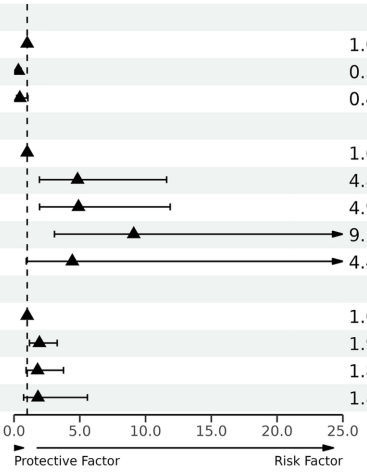

FIGURE 1
Forest plot of odds ratios (ORs) for 3 predictors included in the prediction mode.

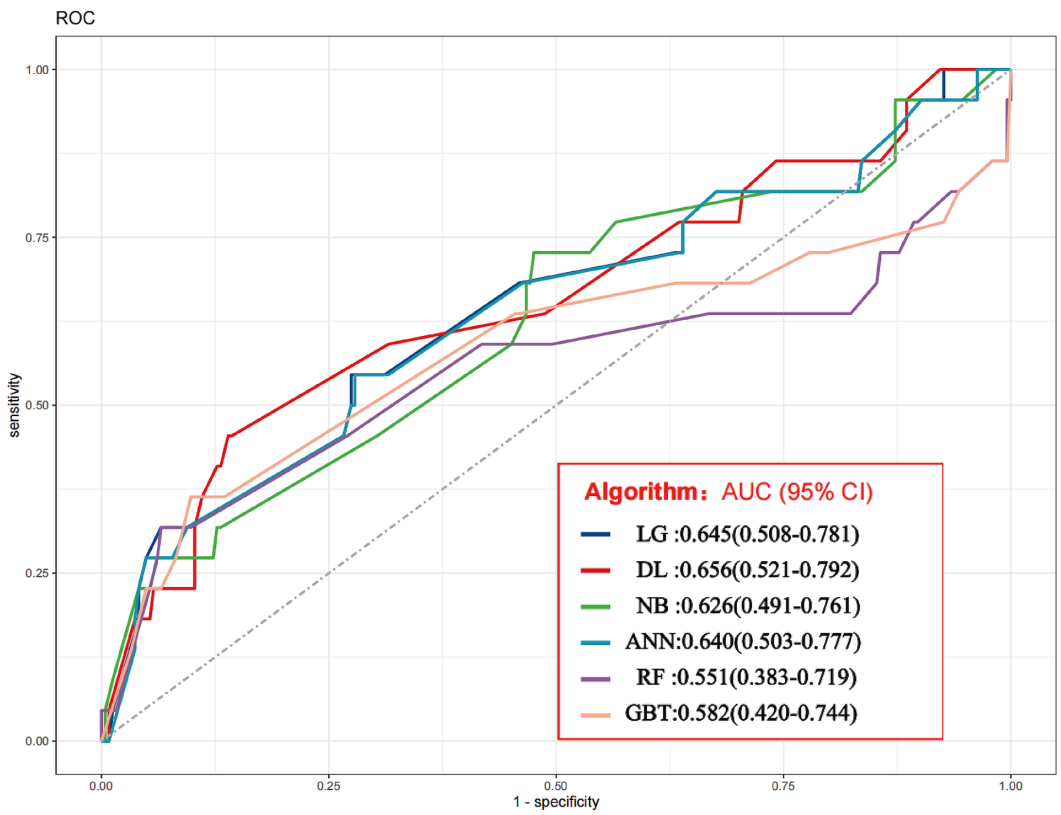

FIGURE 2
The ROC curves of the six model.

4.2 Analysis of influencing factors

Multiple stepwise logistic regression analysis revealed that weight change, job title, and tea consumption during assistance affected sleep quality. While previous studies suggest a link between obesity, poor sleep, and depression (23, 24), our findings show that weight gain may improve sleep quality in healthcare workers. This discrepancy could be due to our study's small sample size. As they gain higher job titles, healthcare workers are often required to take on more important and urgent medical tasks at work. At the same time, due to the specialized and complex nature of medical knowledge, health care workers need to continuously learn and gain experience, and health care workers with lower job titles sometimes need to rely on the training and guidance of their

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TABLE 8 Performance metrics and practical application significance of six models.

Algorithm	Discrimination tests							Practical application significance
	AUROC (95% CI)	Accuracy (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)	Precision (95% CI)	F1-score (95% CI)	KAPPA (95% CI)	
Logistic regression	0.645 (0.508–0.781)	0.711 (0.712–0.709)	0.545 (0.754–0.337)	0.725 (0.781–0.669)	0.152 (0.231–0.073)	0.238 (0.354–0.120)	0.124 (0.230–0.018)	Screening[a]
Deep learning	0.656 (0.521–0.792)	0.827 (0.828–0.826)	0.455 (0.663–0.246)	0.861 (0.904–0.817)	0.227 (0.351–0.103)	0.303 (0.459–0.145)	0.217 (0.368–0.065)	Confirming positive cases[b]
Naïve Bayes	0.626 (0.491–0.761)	0.541 (0.543–0.540)	0.727 (0.913–0.541)	0.525 (0.587–0.462)	0.121 (0.177–0.066)	0.207 (0.297–0.118)	0.077 (0.144–0.010)	Screening[c]
Artificial neural network	0.640 (0.503–0.777)	0.707 (0.708–0.705)	0.545 (0.754–0.337)	0.721 (0.778–0.665)	0.150 (0.228–0.072)	0.235 (0.350–0.119)	0.121 (0.226–0.016)	Screening[a]
Random forest	0.551 (0.383–0.719)	0.883 (0.884–0.883)	0.318 (0.513–0.124)	0.934 (0.965–0.903)	0.304 (0.492–0.116)	0.311 (0.502–0.120)	0.247 (0.433–0.062)	Confirming positive cases[b]
Gradient boosted trees	0.582 (0.420–0.744)	0.857 (0.858–0.856)	0.364 (0.565–0.163)	0.902 (0.939–0.864)	0.250 (0.400–0.100)	0.296 (0.468–0.124)	0.220 (0.388–0.051)	Confirming positive cases[d]

[a]Both specificity and sensitivity are at a moderate level.
[b]Not suitable for screening, but suitable for confirming positive cases, especially in scenarios that require high specificity.
[c]Suitable for preliminary screening, but further optimization is needed to reduce false positive results.
[d]Suitable for confirming positive cases, but further optimization is needed to improve sensitivity.

supervisors to perform their work independently (25). Therefore, medical and nursing staff with higher titles need to learn and accumulate experience. As a result, health care workers with higher titles may experience higher work stress and be in a more stressful and anxious mental state when facing high-risk medical tasks for long periods of time, which may affect their sleep quality. Moreover, the prolonged nature of these high-stress responsibilities—such as extended shifts, complex medical tasks, and the emotional toll of dealing with critically ill patients—can lead to burnout, a well-established factor contributing to poor sleep quality. The heightened stress levels experienced by senior medical personnel may also result in difficulties "switching off" from work, making it harder for them to relax and fall asleep after intense working hours. As a result, they may experience disturbed sleep patterns, including difficulty falling asleep, frequent awakenings, and reduced sleep quality overall.

Tea contains caffeine, and drinking tea before bed can disrupt sleep and reduce sleep quality (26, 27). In fact, caffeine administration has been used as a model for insomnia (28). Medical personnel may be under prolonged stress, and when placed in an unfamiliar environment may be more in need of tea, coffee, and other refreshments. As Fujian is a region with a strong tea culture, the personnel providing aid in Shanghai were more inclined to choose to refresh with tea, thus leading to poor sleep quality; this degree of sleep deprivation, if experienced for longer than one night, may adversely affect daytime functioning (29). Poor sleep could be both a cause and a consequence of caffeinated beverage consumption. The affected medical personnel thus drink more tea, and so repeatedly enter the cycle of poor sleep quality. Secondly, regarding smoking and alcohol consumption, it is important to note that these behaviors might have been less prevalent or less impactful during the assistance period. For instance, smoking might not have been as common among the medical personnel participating in the study, or its effects on sleep quality might have been overshadowed by the more immediate stressors of the work environment. Additionally, alcohol consumption was likely restricted or prohibited during the assistance period due to the need for clear-headedness and professionalism in a high-stakes medical setting. As a result, the potential impact of alcohol on sleep quality was minimal. In conclusion, the significant impact of tea consumption on sleep quality during the assistance period can be attributed to its widespread use as a coping mechanism in a high-stress environment, while other lifestyle factors such as smoking and alcohol consumption did not significantly affect sleep quality.

4.3 Advantages

Previous articles have also used deep learning methods to predict sleep disturbances in asthma patients (30), but this is the first instance of the development and establishment of a prediction model for sleep quality in frontline healthcare workers involved in medical assistance. The prediction model we developed demonstrates outstanding specificity (true negative rate) but has low sensitivity (true positive rate). This indicates that the likelihood of misdiagnosis is lower than that of underdiagnosis when determining the presence of sleep disturbances. Given that the prognosis for sleep disturbances is generally better than for severe conditions like malignant tumors, the psychological stress caused by misdiagnosis can be considerable. Therefore, the risks

associated with misdiagnosis are more harmful in this context. The application of a deep learning model (DL model) can help mitigate these risks. Consequently, when the model indicates a positive result, the presence of sleep disturbances should be highly suspected. This advantage helps in selecting individuals with poor sleep quality and intervening actively to reduce the adverse effects of reduced sleep quality in health workers. Therefore, the generated model is beneficial for understanding the sleep status of frontline medical workers providing assistance in Shanghai aid and also aids in the screening of sleep disturbances.

Our results indicate that by collecting only a few key variables, we can potentially predict the sleep quality of frontline personnel using deep learning (DL) technology. This predictive capability would be beneficial for monitoring the sleep quality of medical staff during future unknown pandemic situations or similar high-intensity work. Ultimately, it provides an effective tool to enhance both the sleep quality and overall quality of life for healthcare workers. Improved sleep can help these individuals maintain better psychological and physical well-being, enabling them to effectively manage frontline prevention efforts and sustain a healthy healthcare environment.

4.4 Limitations

There are some limitations to this study. Data collection dimensions: First, we used a snowball sampling method based on an online questionnaire, which makes our sample dependent on the online web environment and potentially prone to selection bias. This bias may cause the distribution of healthcare workers in the sample to be misaligned with the true demographic and occupational characteristics of the overall population, particularly concerning factors such as gender, age, and professional experience. Additionally, in this sample, all data were self-reported; as a result, we have no objective measures of sleep quality and participants' insomnia and health status prior to HAI are unknown, which limits our interpretation of the results. Second, ours is a cross-sectional survey, which limits the ability to interpret the causal relationships between the different variables in this study and to determine associations and causality more precisely. In addition, due to the inevitable defects of the questionnaire via social media, some selection bias may be caused, which we hope to be further improved in future studies. Finally, because our study was limited to frontline medical personnel in Fujian Province who provided assistance in Shanghai.

5 Conclusion

This study shows that the sleep quality of frontline medical personnel in Fujian Province was affected by providing aid in Shanghai. Weight change, job title, and tea consumption during assistance were the main influencing factors. The DL model showed strong predictive power for sleep quality among frontline healthcare workers, but its low sensitivity limits its ability to accurately identify all sleep disturbances. While promising, the model should be used with caution and may require further validation and integration with other methods for improved accuracy.

Our findings may provide an effective tool for improving the sleep quality and overall quality of life of frontline healthcare workers during volatile public health epidemics. Our study will also help improve the sleep quality of healthcare workers in possible unexpected situations with long workloads and provides relevant suggestions to reduce the degree to which sleep quality is affected, improving the sleep quality of healthcare workers.

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

This study was approved by the Medical Ethics Committee of the Second Affiliated Hospital of Fujian Medical University (IRB No. 2021-309). Written informed consent for participation was obtained from all participants and/or their legal guardians for this study. This study was carried out following the Helsinki Declaration contents. Written informed consent was not required for the publication of potentially/indirectly identifying information, in accordance with the local legislation and institutional requirements. The social media data was accessed and analyzed in accordance with the platform's terms of use and all relevant institutional/national regulations.

Author contributions

SH: Data curation, Investigation, Writing – original draft, Writing – review & editing. QC: Formal analysis, Supervision, Validation, Writing – original draft, Writing – review & editing. SQ: Formal analysis, Investigation, Writing – review & editing. RD: Formal analysis, Supervision, Validation, Writing – review & editing. LY: Data curation, Formal analysis, Investigation, Writing – review & editing. JZ: Formal analysis, Investigation, Validation, Writing – review & editing. ZW: Formal analysis, Writing – review & editing. YZe: Writing – review & editing. JF: Conceptualization, Formal analysis, Methodology, Writing – review & editing. YZh: Conceptualization, Methodology, Supervision, Writing – review & editing.

Funding

The author(s) declare that financial support was received for the research and/or publication of this article. This work was supported by the Fujian Provincial Health and Family Planning Commission, China (Grant No. 2021GG01010048), the Natural Science Foundation of Fujian Province, China (Grant No. 2022J01792), and Quanzhou Science and Technology Project, China (Grant No. 2021C061R).

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.

Generative AI statement

The authors declare that no Gen AI was used in the creation of this manuscript.

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Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpubh.2025.1406062/full#supplementary-material

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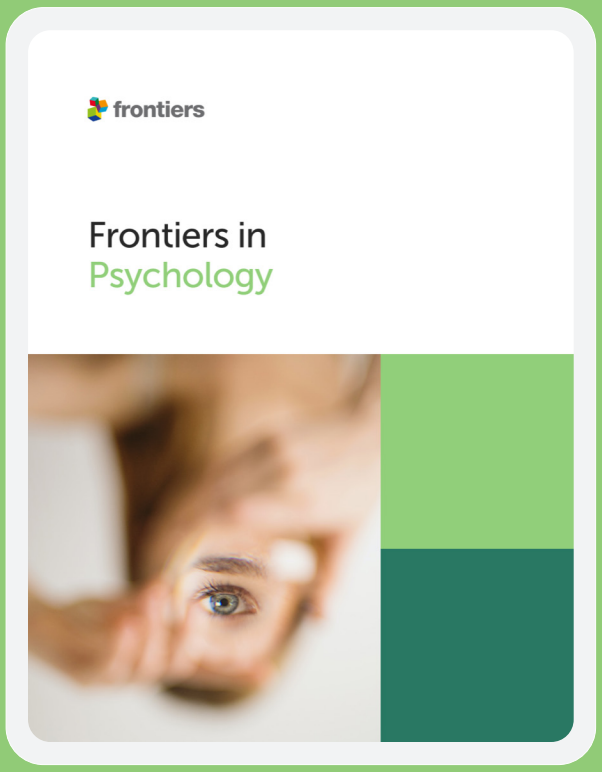

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