Assessing and evaluating the psychosocial impact of the COVID-19 pandemic on anxiety and stress: Perspectives from East Asia

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Assessing and evaluating the psychosocial impact of the COVID-19 pandemic on anxiety and stress: Perspectives from East Asia

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Editorial: Assessing and evaluating the psychosocial impact of the COVID-19 pandemic on anxiety and stress: perspectives from East Asia

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Editorial on the Research Topic
Assessing and evaluating the psychosocial impact of the COVID-19 pandemic on anxiety and stress: perspectives from East Asia

Introduction

Large-scale epidemics like COVID-19 often trigger panic and anxiety in the public (1). In fact, a number of studies have shown that the epidemic has triggered a massive mental health crisis across the globe (2). In the case of East Asia, people have experienced prolonged quarantine and lockdown measures, which had a profound impact on their lives (3). It has been proved that the extended duration of quarantine and lockdown during the COVID-19 outbreak period led to increased feelings of anxiety and stress among the public (4). For example, an online survey conducted in China found that during the peak of the epidemic, about 35% of respondents reported that they felt moderate to extreme psychological stress, and about 20% reported an increase in their anxiety compared to the norm (5).

COVID-19 profoundly impacted mental health, social interactions, and lifestyle (6). For example, during periods of quarantine, there can be a negative impact on the quality of a person's life, which can affect psychological burdens (7). Even cause serious mental health problems, such as posttraumatic stress symptoms (8). Still, it also caused social exclusion negatively related to control over COVID-19 threat and quality of life (9). Meanwhile, the virus caused stigmatization of potentially infected individuals and harm their mental health and social relationships, especially in Hubei (10).

The East Asian region has accumulated considerable experience in dealing with infectious diseases, such as the 2003 SARS epidemic, resulting in significant achievements in public health policy and institution-building in these countries and regions from a historical perspective (11). The Japanese government swiftly implemented a series of countermeasures against COVID-19, including travel restrictions, activity limitations, and temporary school closures (12). Although strict epidemic prevention policies and control measures yielded significant results, their consequences are increasingly evident. Prolonged quarantine, travel restrictions, and social distancing may heighten the risk of psychological distress, including anxiety and depression (13).

Coping styles in East Asia should be adapted to cultural contexts and population characteristics. Western cultures rely on sharing emotions and seeking support to cope with stress (14). In collectivist cultures in East Asia, people may deal with emotions more through internalization, deep reflection and dealing with emotions alone, avoiding causing problems for others in the process (15). Specifically, introspective and self-adjustment approaches may be effective in promoting mental health in East Asia. In China, utilizing family support networks and community resources is suggested as an effective way to cope with epidemic stress (16). Coping COVID-19 can be improved by boosting family psychological support and utilizing community resources like hotlines. Stress and anxiety management in East Asia should suit its cultural and population traits.

Structure and contribution of the Research Topic

The manuscripts in this Research Topic are summarized in Table 1, and we we've made some comments about these manuscripts in this editorial.

Factors associated with anxiety and stress and the relationship between different variables during the COVID-19 pandemic

The following three articles examine the associations between COVID-19, anxiety, and stress.

In the first article, Sun et al. examined depression and anxiety prevalence and factors in isolated or quarantined populations under lockdown. Results showed that higher education, healthcare worker infections, prolonged isolation, and high perceived stress levels were risk factors. The study also found an association between perceived social support and depression/anxiety, mediated by perceived stress and self-efficacy. The study recommends psychological strategies promoting social support and self-efficacy to alleviate depression and anxiety in isolated or quarantined populations.

The second article investigated the role of coping styles and resilience in the face of uncertainty and anxiety caused by COVID-19. Wang T. et al. explored the relationship between uncertainty tolerance, anxiety, and coping styles. Results found that the tested students had higher anxiety scores than the Chinese standard, and uncertainty tolerance was positively correlated with anxiety. Positive coping styles had a negative impact on anxiety, while negative coping styles had a positive impact. Resilience moderated the effect of negative coping styles on anxiety. The study concluded that high uncertainty tolerance reduced psychological burdens during the pandemic. Healthcare workers can utilize coping styles and resilience knowledge to counsel and assist students with physical discomfort and psychosomatic disorders.

Guo L. et al. explored the link between COVID-19 stress, anxiety, and cyber-aggressive behaviors. They utilized a moderated mediation model to investigate the underlying factors, with anxiety as the mediator and perceived anonymity as the moderator. A survey of 3,069 first-year Chinese university students assessed COVID-19 stress, anxiety, cyber-aggressive behavior, and perceived anonymity. Findings revealed a positive relationship between perceived stress and online aggressive behavior, moderated by anxiety. Additionally, perceived anonymity further moderated the relationship between stress/anxiety and online aggressive behavior. The study suggests implementing psychological strategies to alleviate anxiety and perceived anonymity, and to address online aggression during COVID-19.

The above three articles focused on the link between COVID-19, anxiety, and stress in non-healthcare groups. The following four articles focused on changes in the psychophysiological status of healthcare workers and patients, along with influencing factors and relationships.

Geng et al. analyzed psychological symptoms and burnout among frontline healthcare workers in fever clinics during various COVID-19 pandemics. The study included 162 participants surveyed during pandemic and non-pandemic periods. Results indicated prevalent anxiety, depressive symptoms, and burnout among healthcare workers. Although depression decreased as the pandemic severity lessened, anxiety and burnout remained high. Self-efficacy was identified as a crucial factor in protecting frontline healthcare workers from burnout. The study recommended the development of institutional support and intervention programs for these workers.

The second article aimed to assess the prevalence and risk factors of anxiety disorders in COVID-19 patients hospitalized in a Malaysian teaching hospital. Tan et al. compared adult COVID-19 patients with a hospitalized control group and found significantly higher prevalence of anxiety disorders among the COVID-19 patients. The severity of GAD-7 was also notably higher in the COVID-19 group. COVID-19 diagnosis and neurologic symptoms were identified as significant predictors of patient anxiety. The study recommended early mental health attention and psychiatric referral for COVID-19 patients.

In the next article, He et al. compared CD3, CD4, CD8, CD19, and CD56 lymphocytes in 158 frontline medical staff and 24 outpatient medical staff to assess immune function changes in those treating COVID-19 patients. The study found significantly lower absolute values and percentages of CD19+ B-cells in frontline medical staff, especially in females and those over 40. Additionally, lower absolute CD4+ T cell values were observed in medical staff under 40, while those over 40 showed lower CD8+ T cell percentages and higher CD56+ NK cell percentages. The study underscores the importance of prioritizing mental health and immune function in frontline medical staff, along with providing suitable psychological support and care measures.

In the final article in this section explored factors influencing posttraumatic stress disorder (PTSD) symptoms among healthcare workers in the COVID-19 pandemic. Using data from 443 workers in Shandong Mental Health Centers, the research found that 45.37% exhibited severe PTSD symptoms. High exposure to COVID-19 was directly linked to symptom severity, while euthymia and perceived social support were inversely correlated. Yin et al. also found that exposure to COVID-19 partially mediated PTSD symptoms through euthymia and was moderated by social support from friends, leaders, relatives, and colleagues. Enhancing euthymia and bolstering social support could alleviate PTSD symptoms in healthcare professionals during the COVID-19 crisis.

TABLE 1 Summary of contributions to the Research Topic.

No	References	Title	Purpose	Views
1	Sun et al.	*COVID-19 Pandemic-related Depression and Anxiety under Lockdown: The Chain Mediating Effect of Self-Efficacy and Perceived Stress*	The objective of this study was to explore the prevalence and associated factors of depression and anxiety in isolated or quarantined populations under lockdown.	819
2	Wang T. et al.	*The Relationship Between Intolerance of Uncertainty, Coping Style, Resilience, and Anxiety During the COVID-19 Relapse in Freshmen: A Moderated Mediation Model*	The innovation of this study is the first to explore the mechanism of coping style and resilience as people's psychological protective factors between uncertainty and anxiety caused by the COVID-19 pandemic.	1,577
3	Geng et al.	*Emotional Distress and Burnout at A Fever Clinic in China: Comparison Between Different Periods of Covid-19*	The aim of this study was to examine the psychological symptoms and occupational burnout of FHWs in a fever clinic during different periods of the pandemic.	526
4	Yin et al.	*Posttraumatic Stress Disorder Symptoms Among Healthcare Workers During the Omicron Era*	The objective of this study was to clarify the factors that influenced health workers' posttraumatic stress disorder (PTSD) symptoms.	676
5	Tan et al.	*Anxiety Among Hospitalized Covid-19 Patients: A Case–Control Study from a Tertiary Teaching Hospital in Malaysia*	The aim of this study was to estimate the prevalence of and risk factors of anxiety in COVID-19 patients compared to controls in a local tertiary teaching hospital in Malaysia.	779
6	He et al.	*Comparison of Peripheral Blood T, B, and NK Lymphocytes Between Frontline Medical Workers for Treating Patients of Covid-19 and Normal Outpatient and Emergency Medical Workers in China*	The aim of this study was to compare the differences in mental health and immune function between 158 frontline medical workers and 24 controls from medical staffs of the outpatient and emergency departments.	693
7	Tian et al.	*Translation, Adaptation, and Initial Evaluation of a Guided Self-Help Intervention to Reduce Psychological Distress Among Nurses During Covid-19 in China*	The objective of this study was to translate and adapt the SH+ guideline into the Chinese version and to test its feasibility in reducing psychological distress among nurses during COVID-19.	560
8	Ding et al.	*A Multifactorial Framework of Psychobehavioral Determinants of Coping Behaviors: An Online Survey at the Early Stage of the Covid-19 Pandemic*	The objective of this study was to try to identify the major coping-behavior and risk-perception factors. And then examined important demographic, risk-perception, and psychobehavioral factors that contributed to coping behavior.	541
9	Wang Y. et al.	*A Decline in Perceived Social Status Leads to Post-Traumatic Stress Disorder Symptoms in Adults Half a Year After the Outbreak of the Covid-19 Pandemic: Consideration of the Mediation Effect of Perceived Vulnerability to Disease*	The aim of this study was to examine the impact of perceived social status decline on the prevalence of PTSD symptoms and check the mediating effect of perceived vulnerability to disease (PVD) during the period of psychological adjustment.	704
10	Guo Z. et al.	*Family Function and Anxiety Among Junior School Students During the Covid-19 Pandemic: A Moderated Mediation Model Perceived Covid-19 Stress and Online Aggression Among Chinese First-Year College Students: A Moderated Mediation Model*	The purpose of this study was to explore the mediating and moderating mechanisms underlying this relationship among junior school student during the COVID-19 pandemic.	542
11	Guo L. et al.	*Perceived COVID-19 Stress and Online Aggression Among Chinese First-Year College Students: A Moderated Mediation Model*	The aim of this study was to examine a moderated mediation model with anxiety as a mediator and perceived anonymity as a moderator.	642
12	Wan et al.	*Psychological Resilience Matters in the Relationship Between the Decline in Economic Status and Adults' Depression Half a Year After the Outbreak of the COVID-19 Pandemic*	This article studied the prevalence of depression among the population of Hubei Province since the pandemic is of great significance.	611

During the epidemic, people faced numerous social, demographic, and economic challenges that exacerbated anxiety and stress. The following three articles focus on social, demographic and economic factors related to anxiety and stress during the epidemic.

In the first article, based on cognitive-relational theory, Wang Y. et al. studied how perceived social status decline affects PTSD symptoms through perceived disease susceptibility (PVD) during mental adjustment. Findings reveal lower social status correlating with worsened PTSD, while PVD offered slight buffering. Emphasizing subjective social status in health outcomes,

the study suggests improving community social support to boost mental health perceptions.

The second one, Guo Z. et al. investigated family function, anxiety, mediators, and moderators in 745 middle students during COVID-19. Homebound students reported lower family function, higher stress, and anxiety. Results showed: (1) Left-behind (LB) junior students had lower function, higher stress, and anxiety; (2) Family function negatively linked to anxiety with stress as mediator; (3) LB status moderates the connection between function, anxiety, and stress. These findings enhance anxiety prevention in middle schoolers during the pandemic.

In the final article in this section, Wan et al. examined the connection between economic status decline and adult depression in the 6 months post-COVID outbreak, focusing on the role of psychological resilience. Findings indicated that depression severity heightened as economic status declined, with each unit drop relating to an approximate 0.117 unit increase in depression severity. Also, psychological resilience was found to play a significant moderating role. The study emphasizes the impact of economic status on depression and proposes solutions to improve mental health during pandemics.

Coping styles used to cope with anxiety and stress during the COVID-19 epidemic and their coping outcomes

This section discusses various coping strategies that can be developed and encouraged to enhance and maintain individuals' physical and mental health during an epidemic, along with the effects resulting from these coping styles.

The first article aimed to use the World Health Organization's Self-Help Plus (SH+) intervention, adapted for the Chinese context, to alleviate nurses' psychological distress during the COVID-19 pandemic. The study conducted in two Xi'an hospitals involved translation, adaptation, and evaluation through a pilot implementation involving 20 nurses. Results showed significant reductions in distress, improvements in psychological flexibility, wellbeing, and depressive symptoms. Despite adherence difficulties, Tian et al. found the Chinese SH+ version feasible for use in China and potentially helpful for nurses during COVID-19, but recommended exploring strategies to improve adherence.

The second article by Ding et al. aimed to identify factors impacting coping-behavior during a pandemic. Using hierarchical multiple regression analyses, it identified four coping-behaviors and three risk perception factors and their correlations. It revealed positive correlations between different coping behaviors and factors such as femininity, rituals, risk perception, leadership, etiquette, and wellbeing. This simplified model aids in understanding social dynamics during a pandemic and offers a theoretical framework for coping behaviors.

Future research

The study focuses on the mental health impact of COVID-19 on East Asia's general population and healthcare workers' resilience. It delves into the psychological shifts, influential factors, and adaptability modes in response to the pandemic. Findings indicate that education, job status, isolation duration, and perceived stress can affect mental health. Enhancing social support, self-efficacy, and reducing stress improves mental health. Coping strategies include self-help interventions and resilience training, requiring appropriate translation for East Asian groups to increase intervention efficiency.

Future studies should explore the epidemic's mental health impacts and devise more effective coping strategies for the public and healthcare professionals. They could utilize longitudinal studies to gauge when interventions are most effective. Research should also focus on unique groups like the youth, elderly, and disabled, who might require specialized interventions. Additionally, assessing the measures' long-term efficacy and sustainability in improving mental health is crucial.

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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Check for updates

The relationship between intolerance of uncertainty, coping style, resilience, and anxiety during the COVID-19 relapse in freshmen: A moderated mediation model

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Background: The repeated outbreaks of COVID-19 and the rapid increase in uncertainty have had many negative effects on the public's mental health, especially on emotional aspects such as anxiety and depression. However, in previous studies, there are few studies exploring the positive factors between uncertainty and anxiety. The innovation of this study is the first to explore the mechanism of coping style and resilience as people's psychological protective factors between uncertainty and anxiety caused by the COVID-19 pandemic.

Methods: This study explored the relationship between intolerance of uncertainty and anxiety of freshmen with coping style as mediating variable and resilience as moderating variable. A total of 1049 freshmen participated in the study and completed the Intolerance of Uncertainty Scale (IUS-12), Self-rating Anxiety Scale (SAS), Simplified Coping Style Questionnaire (SCSQ), and Connor-Davidson Resilience Scale (CD-RISC).

Results: SAS score of the surveyed students (39.56 ± 10.195) was significantly higher than that of the Normal Chinese score (29.78 ± 10.07, $p < 0.001$). Intolerance of uncertainty was significantly positively correlated with anxiety ($\beta = 0.493$, $p < 0.001$). Positive coping style has a significant negative impact on anxiety ($\beta = -0.610$, $p < 0.001$), negative coping style has a significant positive impact on anxiety ($\beta = 0.951$, $p < 0.001$). Resilience moderates the second half of the influence of negative coping style on anxiety ($\beta = 0.011$, $t = 3.701$, $p < 0.01$).

Conclusion: The findings suggest that high levels of intolerance of uncertainty had negative effects mental burden during the COVID-19 pandemic. The knowledge of the mediating role of coping style and the moderating role of resilience may be used by health care workers when consulting freshmen with physical health complaints and psychosomatic disorders.

KEYWORDS

COVID-19, intolerance of uncertainty, coping style, resilience, anxiety, freshmen

1. Introduction

The COVID-19 pandemic has developed into a global public health emergency. It is highly variable, highly contagious, and most individuals in the population are susceptible (1). According to WHO data, as of December 2022, there have been more than 600 million infections worldwide, including more than 6.6 million deaths. Since the outbreak of COVID-19, the Chinese government and the scientific community have acted swiftly to identify the cause of the disease, while implementing a series of timely and effective measures to contain the spread of the disease. Although the government's COVID-19 restriction strategy has effectively prevented the spread of the corona virus, it has had a negative impact on people's mental health, especially long-term closed-off management (2). The COVID-19 pandemic has clearly exposed human vulnerability. It is a historic global health crisis that continues to wreak havoc on millions of lives. Uncertainty and health-related anxieties grow organically in the peri-pandemic and post-pandemic periods. People fear infection, ineffective prevention, inadequate intervention efforts, and uncontrolled viral spread. It is clear that the public is not clear about this (3). We are all asked to cope with the ensuing uncertainty. It has a strong impact on college students, especially the freshmen. They are required to work hard to adapt to the new learning lifestyle, but also to make considerable efforts in managing their mental health (4).

A personality trait caused by negative beliefs about uncertainty and its effects is called intolerance of uncertainty (IU). It may also be an important part in anxiety disorders and depression (5). Freeston et al. first proposed an operational definition: IU is a cognitive, emotional, and behavioral response to ambiguous situations and unknown events. Specifically, the cognitive performance of uncertainty is confusing; emotional reactions include frustration and stress; in behavior, trying to control the future and avoid uncertainty, inhibit uncertainty may lead to behavior. Ladouceur, Gosselin, and Dugas emphasize negative evaluations of uncertainty. Regardless of the probability of an uncertain situation or event occurring, and the consequences, individuals with a high intolerance to uncertainty tend to evaluate it negatively. Dugas, Schwartz, and Francis gave a more pertinent definition on the basis of a comprehensive study of the various concepts. They believe that intolerance of uncertainty is a cognitive bias that perceives, interprets and reacts to uncertain situations or events, which affects individual cognition, emotion and behavioral responses (6). In the face of threats, the lower the tolerance of uncertainty, the easier it is to feel anxious, that is, people who cannot tolerate high uncertainty are more likely to have strong anxiety. Thus, we posit the following hypothesis:

> **H1:** Intolerance of uncertainty is positively associated with anxiety.

The outbreak of COVID-19 has further increased the level of anxiety among college students. Since 2020, a number of studies have shown that the rate of anxiety among college students in China exceeds 20%, or even more than 40%, of which the cumulative incidence of moderate and severe anxiety exceeds 3% (7, 8). A one-year longitudinal follow-up study showed that during the COVID-19 pandemic, the severity of anxiety among Chinese college students increased significantly, and Sporadic cases still leave college students with a marked increase in anxiety when faced with new

cases in their city (9). Although China has already controlled the spread of the epidemic, follow-up studies have found that the anxiety symptoms of college students after the epidemic became normalized were higher than during the initial outbreak (10). For college students, the COVID-19 epidemic is a serious source of stress, and the "unknown/unpredictable sense" it brings has caused great uncertainty to college students. According to the cognitive assessment theory of R. S. Lazarus (11), emotion is the response of individuals to cognition and assessment of the environment. Uncertainty is disgusting, and individual differences that are intolerable to uncertainty affect emotional responses (12). Individuals with high intolerance of uncertainty tend to make a threatening assessment of uncertainty, which leads to fear, anxiety and other aversion reactions (6). Coping is an individual's cognitive and behavioral efforts to mitigate the negative effects of the environment, while coping styles are the coping strategies that individuals adopt when facing the environment (13). Coping styles can be divided into positive and negative aspects based on their common characteristics. Positive coping styles are more mature and usually include problem solving, help seeking, cognitive adjustment, etc., similar to problem-oriented coping styles, while negative coping styles are relatively immature and include self-blame, avoidance, fantasy, etc., similar to emotion-oriented coping styles (14). The unexpected event of repeated outbreaks of the COVID-19 pandemic creates a high degree of uncertainty, and individuals' perceptions and opinions of uncertainty influence not only their emotional experiences (15) but also their coping responses to stressors. With the influx of ever-changing and repeated information following the COVID-19 pandemic, individuals who cannot tolerate high levels of uncertainty in the face of these uncertain stimuli often developing negative perceptions and experience negative emotions (16). To cope with these stimuli and the negative emotions and to restore psychological balance, individuals engage in behavioral coping (convergence or avoidance of uncertainty). Furthermore, adaptive outcomes of stress responses vary depending on the coping style. Studies have shown that uncertainty intolerance affects mental health during COVID-19, and coping styles play a mediating role (17). Thus, we posit the following hypothesis:

> **H2:** The mediating role of coping style between intolerance of uncertainty and anxiety. The model diagram of our mediation hypothesis is shown in **Figure 1**.

Resilience is universal, and it has a protective effect on physical and mental conditions when individuals experience or face adversity (18). Psychological resilience can help individuals after experiencing severe stress or trauma, it allows for good internal control, better adaptation to stressful situations, and a return to pre-crisis conditions to maintain mental health (19). A growing body of literature suggests that resilience helps individuals ward off depression, anxiety, and other negative mental health conditions (20). Psychological resilience may also help mitigate adverse psychological outcomes associated with COVID-19 (21). Research has found that psychological resilience is a protective factor in the psychological impact of the COVID-19 pandemic on people. With the continued impact of the COVID-19 pandemic, especially in the form of health and psychological stress, people in their respective regions need to quickly adapt their thinking and lifestyle to the new changes. Therefore, the role and value of psychological resilience on the physical and

Model hypotheses for mediating coping styles on intolerance of uncertainty and anxiety.
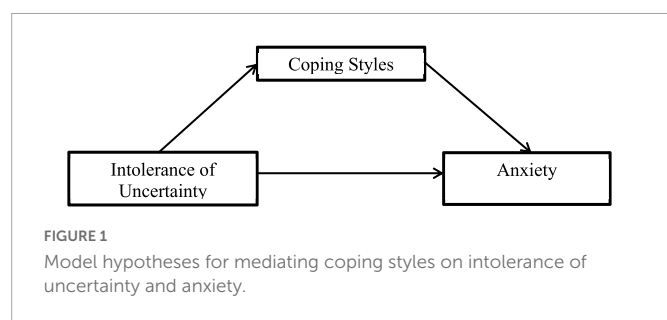
mental health status of college students deserves more attention (22). Resilience is defined as positive psychological characteristics that enable individuals to cope effectively with stressful situations. Studies have shown that individuals with high psychological resilience and positive coping styles have lower levels of anxiety and depression during a novel coronavirus pneumonia outbreak (23). Thus, we posit the following hypothesis:

> **H3:** Resilience moderated the effect of negative coping style on anxiety. The model diagram of our moderated mediation function hypothesis is shown in **Figure 2**.

Even before the COVID-19 pandemic, the mental health of college students was a growing concern. The stresses and limitations associated with a pandemic put college students at greater risk for mental health problems, which can severely impact their academic success, social interactions, and future professional and personal opportunities (24). College is a critical period in life, freshman year is the beginning of college life, the personal experiences during this period will affect the growth and development of individuals. Freshmen mainly have developmental and adaptive psychological confusion. Even a few students have serious psychological problems need to be taken seriously. As a special stress group, freshmen are in the transition from parental dependence to independence and from student to socialite (25).Studies have shown that there are significant differences in mental health problems of freshmen in terms of gender, geography, and discipline (26). The study found that the characteristics of freshmen are below: strong herd mentality, simple thinking, strong sense of pride and superiority, unrealistic illusions about college life, strong self-esteem, poor tolerance, and uncertainty of study attitude (27). In summary, as far as we know, Currently, research on individual mental health and coping styles during the COVID-19 epidemic has focused on medical personnel, the general population, and patients with the COVID-19 epidemic (28), there are few studies on the mental health level of freshmen during the

A hypothetical model of psychological resilience to regulate the effects of intolerance of uncertainty on anxiety through coping styles.
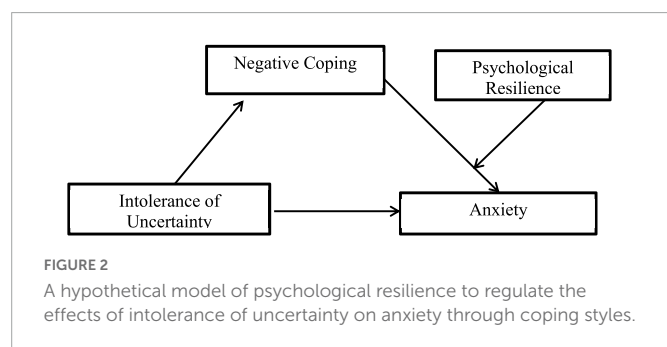
repeated COVID-19 pandemic. Therefore, this study focuses on freshmen as the research objective. This study is the first to explore the important buffering effect of intolerance of uncertainty, coping style and resilience on the anxiety of freshmen, and to study the mechanism of intolerance of uncertainty on the anxiety of freshmen, a special pressure group, through positive and negative coping and positive psychological resources (resilience).

2. Materials and methods

2.1. Participants

A total of 1,049 freshmen participated in the survey. Finally, 1,015 remaining valid data were screened, and the effective recovery rate was 96. 76%. Participants were mainly from two provinces in southern China: 257 from Guangdong Province, 25.3%; 741 from Jiangxi Province, 73%; 17 from other regions, 1.7%. The results showed that 381 were male (37.5%), 634 were female (62.5%); 172 were only child (16.9%), and 843 were non-only child (83.1%); 735 (72.4%) were in the closed-off state, and 280 (27.6%) were in the non-closed off state.

2.2. Procedure

Before each participant fills in the questionnaire, they will be informed that the survey is anonymous, and they need to answer all questionnaire items honestly based on their daily life experience. All results will be based on the principle of confidentiality, only for scientific research reference. The authenticity, independence and completeness of all answers are also emphasized. Data acquisition completed in 20 min.

3. Measures

3.1. Intolerance of uncertainty

Intolerance of uncertainty scale 12 (IUS-12). Developed by Freeston et al. and revised by Buhr and Dugas, consisting of 27 items that assess cognitive, emotional, and behavioral reactions to uncertain situations. It is an assessment tool with a five-item Likert scale (1 = completely inconsistent, 2 = somewhat consistent, 3 = substantially consistent, 4 = very consistent, 5 = completely consistent). The IUS-27 was further simplified by Carleton, Norton and Asmundson into the IUS-12 with 12 items (29). The short version of the Intolerable Uncertainty Scale used in this study was revised by Lijuan Wu in Chinese to form the Chinese version of the short version of the Intolerable Uncertainty Scale (30). It contains three factors: anticipatory behavior, inhibitory behavior, and anticipatory emotion. The final Chinese version of the questionnaire maintains the same items and scoring method as the original questionnaire, with higher scores representing less tolerance of uncertainty, i.e., lower uncertainty tolerance. The revised Chinese version of the IUS-12 has good psychometric properties, with a retest reliability of 0.801. In the present study, the Cronbach's alpha of the scale was 0.908.

FIGURE 3
Freshmen's anxiety self-assessment scores.

coefficient for negative coping was 0.78. The Cronbach's alpha coefficient of the scale in this study was 0.890.

3.4. Psychological resilience

The Psychological Resilience Scale (CD-RISC) consisting of 25 items (35). This scale is the most commonly used scale to measure the "psychological resilience" of individuals in China. It is divided into 3 dimensions, namely optimism, strength and resilience (36). Optimism refers to the individual's confidence in the development of things and the ability to see things from a positive perspective; strength refers to the individual's passion and energy for self-improvement in overcoming adversity; and resilience refers to the individual's perseverance, courage, and strength when under physical or mental stress. The scale is scored on a 5-point scale from "1 = never" to "5 = always." The higher the score, the higher level of psychological resilience. The internal consistency coefficient and retest reliability of the scale were 0.89 and 0.87, respectively, and both performed well. The Cronbach's alpha coefficient in this study was 0.953.

4. Data analysis

Data analysis was performed using SPSS27.0. There are some reverse scoring questions in the questionnaire design, which are converted before analysis. Harman's single factor test was used to analyze the variance of the four questionnaires. Descriptive statistical analysis is used to analyze the correlation of population variables. To explore the bivariate correlation between intolerance of uncertainty, anxiety, coping style and resilience, we used independent sample t-test, Pearson correlation coefficient. The SPSS PROCESS 4.1 plug-in is then used for mediation analysis (37). Model 4 was used to test the mediating role of positive coping style and negative coping style between the independent variable intolerable uncertainty and the dependent variable anxiety. Then Model 7 and Model 14 were used to test the moderated mediation effect of resilience between intolerance of uncertainty and anxiety on the two coping style paths (38). All tests were within the 95% confidence interval. When the confidence

3.2. Anxiety

Self-Rating Anxiety Scale (SAS): SAS was compiled by Zung to monitor the anxiety state of patients in the past week (31). The scale includes 20 items, of which questions 5, 9, 13, 17 and 19 are reverse scoring questions, which are scored on a scale of 1 to 4 (1 = rarely to 4 = most of the time). Directly add the scores of 20 questions to form a rough score. Multiply the rough score by 1.25 and take the integer part to get the standard score. The standard score is less than 50 as non-anxiety, 50–59 as mild anxiety, 60–69 as moderate anxiety, and ≥70 as severe anxiety. The higher the score, the higher level of anxiety (32). The Cronbach'α reliability coefficient of the scale is 0.906.

3.3. Coping style

The Simple Coping Style Questionnaire (SCSQ) was first developed by Xie and Zhang (33). The questionnaire consists of 20 items and is composed of two subscales: positive and negative coping. Among them, the positive coping subscale consists of 1 to 12 questions, focusing on the characteristics of positive coping; the negative coping subscale consists of 13–20 questions, mainly responding to the characteristics of negative coping (34). The internal consistency coefficient of the questionnaire was 0.90, and the reliability of two dimensions was good: the Cronbach's alpha coefficient for positive coping was 0.89, and the Cronbach's alpha

TABLE 1 Descriptive analysis results.

	M	D	1	2	3	4	5	6	7	8	9	10	11
IU	32.87	9.41	1										
PB	15.59	5.50	0.94**	1									
IB	8.25	2.50	0.72**	0.52**	1								
PE	9.03	2.78	0.87**	0.76**	0.52**	1							
PR	79.98	16.14	−0.07*	−0.21**	0.28**	−0.06	1						
Optimism	12.49	2.91	0.01	−0.10**	0.23**	0.02	0.81**	1					
Strength	26.72	5.48	−0.09**	−0.23**	0.25**	−0.07*	0.94**	0.74**	1				
Tenacity	40.77	8.94	−0.07*	−0.20**	0.27**	−0.08*	0.96**	0.68**	0.85**	1			
PC	34.69	6.51	−0.08*	−0.19**	0.18**	−0.05	0.73**	0.58**	0.71**	0.69**	1		
NC	19.64	4.69	0.27**	0.27**	0.14**	0.24**	0.16**	0.22**	0.09**	0.16**	0.32**	1	
Anxiety	49.45	12.74	0.48**	0.52**	0.22**	0.41**	−0.26**	−0.16**	−0.33**	−0.22**	−0.23**	0.35**	1

IU, intolerance of uncertainty; PB, predictability behavior; IB, inhibitory behavior; PE, predictability emotion; PR, psychological resilience; PC, positive coping; NC, negative coping.
*$p < 0.05$; **$p < 0.01$.

TABLE 2 The mediating role of coping style between intolerance of uncertainty and anxiety.

Outcome variable	Factor	β	SE	t	LLCI	ULCI
Anxiety	IU	0.493	0.036	13.799***	0.423	0.563
	PC	−0.610	0.053	−11.588***	−0.713	−0.507
	NC	0.951	0.076	12.566***	0.802	1.099

IU, intolerance of uncertainty; PC, positive coping; NC, negative coping.
***$p < 0.001$.

interval did not include zero, the mediating effect was significant at $p < 0.05$.

5. Results

5.1. Harman factor analysis

In this study, measures such as anonymous answering and reverse scoring of some questions were used to control the common method bias procedurally. The collected data were tested for common method deviation through the Harman factor test. The analysis results showed that a total of 12 factors with eigenvalues greater than 1 were generated, and the maximum factor variance interpretation rate was 18.162% (less than 40%). Therefore, there is no serious common method bias problem in this study.

5.2. Demographic data analysis

The results of demographic variables showed that the SAS score of the surveyed students (39.56 ± 10.195) was significantly higher than that of the Normal Chinese score (29.78 ± 10.07, $p < 0.001$). The SAS score of non-only child was significantly higher than that of only child ($t = 0.335$, $p = < 0.05$), and the SAS score of non-normal online shopping was significantly higher than that of normal online shopping ($t = 3.506$, $p < 0.05$). There was significant difference in SAS scores between "whether or not to buy epidemic-related protective equipment" groups ($F = 4.083$, $p < 0.05$). The IU score of the surveyed students was (32.87 ± 9.410). The IU score in the closed-off state was significantly higher than that in the non-closed off state ($t = 2.294$, $p < 0.05$). The score of IU in the high risk group was significantly higher than that in the low risk group ($F = 2.651$, $p < 0.05$). There was a significant difference in the IU score between the "whether to buy epidemic-related protective equipment" groups ($F = 6.298$, $p < 0.05$).

5.3. Intolerance of uncertainty, anxiety, coping style, resilience variable analysis

Among the samples, 537 had no anxiety symptoms (52.9%), 273 had mild anxiety (26.9%), 158 had moderate anxiety (15.6%), and 47 had severe anxiety (4.6%). As shown in Figure 3.

The descriptive statistics and correlation analysis results of each variable are shown in Table 1. Intolerance of uncertainty was significantly positively correlated with anxiety, significantly negatively correlated with resilience, significantly negatively

FIGURE 4
Mediating role of positive/negative coping style between intolerance of uncertainty and anxiety. The results showed that positive coping style can significantly improve anxiety; negative coping style could significantly positively predict anxiety level. *$p < 0.05$; ***$p < 0.001$.
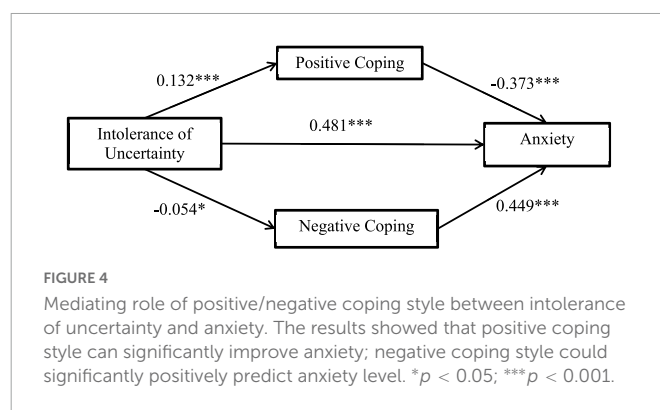
correlated with positive coping style, and significantly positively correlated with negative coping style. Resilience was positively correlated with coping style and negatively correlated with anxiety. Positive coping style was negatively correlated with anxiety, and negative coping style was positively correlated with anxiety.

This study used SPSS extension PROCESS. 4. 1 to test the mediating effect, and the results are shown in Table 2 and Figure 4. With intolerance of uncertainty as the independent variable, anxiety as the dependent variable, and coping style as the mediating variable, Model 4 shows that intolerance of uncertainty has a significant positive impact on college students' anxiety (β = 0.493, $p < 0.001$). Thus, H1 is supported. Positive coping style has a significant negative impact on anxiety (β = −0.610, $p < 0.001$), negative coping style has a significant positive impact on anxiety (β = 0.951, $p < 0.001$), Thus, H2 is supported.

Bootstrap method was used for 5,000 repeated samplings to test the mediating effect of coping style. The results showed that the indirect effect of intolerance of uncertainty on anxiety through coping style did not include 0 in the 95% confidence interval, indicating that the mediating effect of coping style was significant.

Model 14 was used to test the moderating effect of psychological resilience on the second half of anxiety through coping style, the results are shown in Table 3 and Figure 5. The product of negative coping style and resilience had a significant predictive effect on anxiety (β = 0.011, $t = 3.701$, $p < 0.01$), indicating that resilience played a moderating role in the prediction of anxiety by negative coping style. The confidence interval of the model test does not contain 0, indicating that the moderated mediating effect is significant. Thus, H3 is supported. That is to say, the coping style of college students with low level of resilience has a greater impact on anxiety. In summary, the moderated mediation model proposed in this study has been supported by empirical data. Coping style plays a mediating role between intolerance of uncertainty and anxiety,

TABLE 3 The moderating effect of psychological resilience on the influence of coping style on anxiety.

Outcome variable	Factor	β	SE	t	LLCI	ULCI
Anxiety	NC	0.736	0.073	10.131**	0.593	0.878
	R	−0.244	0.021	−11.848**	−0.284	−0.203
	NC × R	0.011	0.003	3.701**	0.005	0.017
	Sex	−1.747	0.661	−2.642**	−3.045	−0.449

PC, positive coping; NC, negative coping.
**$p < 0.01$.
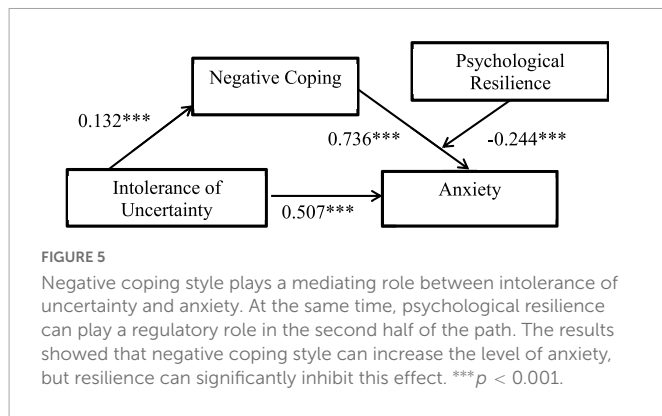
and the second half of the mediating role of negative coping style is regulated by psychological resilience.

6. Discussion

This study was the first to investigate factors associated with negative emotions in freshmen in the context of recurrent outbreaks of the COVID-19 pandemic, exploring the relationship between intolerance of uncertainty, psychological resilience, coping styles, and anxiety. It is also the first study to focus on the mediating role of coping styles between IU and anxiety in freshmen. The details were as follows: freshmen had higher SAS scores than the normal Chinese; IU was positively related to anxiety; coping styles partially mediated the relationship between IU and anxiety; and psychological resilience moderated the effect of negative coping styles on anxiety.

The results show that IU can positively predict individual anxiety level, which verifies our hypothesis 1. The concept of sensitivity to uncertainty has always been considered as an evolutionary adaptive protection factor. In the course of human psychological development, most people learn to be more tolerant of uncertainty, but if they fail to do so, they are more likely to become or remain anxious (39). According to the cognitive model of anxiety, individual perception and evaluation of threat information will affect the generation of anxiety (40). Many studies have linked intolerance of uncertainty to anxiety, and found that intolerance of uncertainty can predict the level of anxiety (41). Chen et al. (42) found that intolerance of uncertainty is an important cognitive risk factor for anxiety and related symptoms. Therefore, this result is also consistent with previous studies (43). According to demographic data analysis, individuals in high-risk areas, in a closed-off state, and unable to shop online normally have shown a high level of intolerance of uncertainty. These performances precisely reflect the cognitive characteristics of college students in the face of uncertain events: the epidemic repeatedly mixed with overwhelming information, and the immaturity of their thoughts makes them more sensitive to the dangerous signals revealed by uncertain events (44), and it is easier to classify fuzzy information as dangerous signals (45). This cognitive bias in the face of serious public health emergencies makes people more likely to produce irrational beliefs and negative emotions (46). Barlow DH. Studies have found that when individuals often experience uncontrollable, they usually cause serious emotional distress and even anxiety disorders (47). This study also supports this result.

The study of Nicholas suggests IU may serve as an important transdiagnostic feature across anxiety disorders and depression (48). This reminds us that when preventing and intervening in college students' mental health problems during the COVID-19 pandemic, on the one hand, we can cultivate and train college students' uncertainty tolerance, on the other hand, we should pay attention to improving college students' emotional regulation ability (49), science emotional theory knowledge and effective regulation methods, so as to enhance their cognition and relief of their negative emotions (anxiety).

The study found that coping style plays a mediating role between intolerance of uncertainty and anxiety. Individuals with low tolerance of uncertainty are prone to psychologically exaggerate the expected possibility and severity of disasters in the face of stressful events or adversity (50). They are more inclined to think they can't cope with the situation, which creates a higher level of anxiety (51), hypothesis 2 is verified of this study. There was no significant difference in coping style between genders. Zhang et al. (52) conducted a survey of 660 college students in Beijing and found that there were significant differences in stress coping styles between only children and non-only children, and between male and female college students. Liu Chunyan and Li Wenquan conducted a study of 204 normal university students and found that when college students face stress, there are significant gender differences in negative coping styles (53). The results of this study are inconsistent with those of the predecessors, which may be due to the suddenness and severity of COVID-19, as well as the large degree of unknowns and sense of lack of control over it, requiring university students to mobilize all internal and external resources to deal with the negative effects of this major public health event (54). Meanwhile, college students are at the stage of transition from dependence on parents to independence and from students to social beings, therefore, both the demands of the environment and the need for self-growth make them choose positive ways to cope, integrate into college life as soon as possible, adapt to the study environment and interpersonal environment of college, and get into the right track of study (55). This may also be due to the fact that with economic development and social progress, the requirements and expectations of society and families for boys and girls are gradually aligned. As a result, both boys and girls are able to cope well with various problems without significant differences (56). But there was significant difference in the frequency of purchasing epidemic protective equipment. Participants who regularly purchased epidemic protection products (such as masks, alcohol sprays, lotus qingwen capsules, etc.) scored higher on positive coping styles. There is a positive correlation between negative coping and anxiety, which is consistent with the results of previous studies. This result is consistent with previous studies (57). The more individuals tend to use positive coping styles, such as cognitive reappraisal, problem solving, and seeking help, the less psychological problems (58); on the contrary, the more obvious the individual negative coping style, such as the more individuals tend to use avoidance coping style, the more negative emotional response, the greater the degree of anxiety (59). In public health emergencies, the anxiety of college students with positive coping style tendency will be reduced, while the negative coping tendency will aggravate the degree of anxiety (60). Therefore, the mediating effect of coping style is significant, which is also consistent with the previous research results (61). This may be because the epidemic situation changes rapidly and the situation is changing. Freshmen have poor tolerance. When they cannot tolerate uncertainty, it will

cause different levels of anxiety, and individual coping styles will indirectly affect anxiety.

In this study, there are significant gender differences in the level of resilience. Cheng et al. showed in the 'National Sampling Survey Report on Resilience of Chinese Adults' that there are gender differences in the average scores of resilience dimensions, which is similar to the results of this study (18). There was a significant correlation between resilience and unbearable uncertainty, different coping styles and anxiety level, and it was statistically significant in regression analysis, which was similar to the results of related studies (62). In order to further explore the mechanism of action between IU, anxiety, resilience and coping style, a moderated mediation model test was conducted, and it was found that psychological resilience can regulate the second half of the impact of negative coping styles on anxiety. This suggests that when individuals face repeated outbreaks and cannot tolerate uncertainty, adopting a negative coping style exacerbates anxiety, and individuals with high levels of resilience weaken this effect. Resilience theory suggests that resilience not only protects individuals in adverse circumstances, but also allows individuals who have already suffered danger and trauma to recover from negative events (63); Resilience, as a protective factor, has been shown to appropriately reduce the association between risk factors in life and depression, which can effectively buffer negative outcomes such as anxiety, depression and post-traumatic stress disorder (64). Therefore, based on the previous theoretical basis and the data support of this study, Hypothesis 3 is supported. The results suggest that attention should be paid to the training of freshmen's problem-solving strategies and skills to enhance their positive coping tendency (65). In the event of a major public health emergency, in the face of various uncertainties, psychological education and psychological training should be increased, which can effectively improve coping styles and psychological resilience (66). Therefore, by increasing psychological training to improve the psychological function of freshmen can be used as a way to solve emotional problems such as anxiety.

In summary, during the recurrence of the COVID-19 pandemic, freshmen generally have a high level of intolerance of uncertainty, a poor level of psychological resilience, and a high level of anxiety. When constructing a psychological intervention system, colleges and universities should focus on factors such as gender and whether they are in a state of containment, give full play to the protective role of psychological resilience, promote students to adopt positive coping styles to face and deal with the uncertainty caused by serious public health emergencies, reduce the generation of negative emotions and maintain normal psychological function (67).

7. Limitations

The above discussion complements the anxiety status of freshmen caused by the repeated period of COVID-19, and demonstrates its psychological mechanism with empirical research, but there are still the following deficiencies: First of all, in theory, although the research has successfully proved the mediating effect of coping style on IU and anxiety, the participants are not representative enough. All participants selected in our study are freshmen, and

their promotion in other groups is insufficient. Secondly, the focus of this study on the mediating and moderating effects between IU and anxiety is mainly on coping style and resilience. There are other variables in reality, such as risk perception, fear of COVID-19, etc., which need to be further studied. Thirdly, this study adopts a cross-sectional design research method, which cannot accurately determine the causal relationship in the study. Future research should use experimental or tracking research to better design and investigate. Fourth, like many self-reported data collection studies, the participants in this study may also have a social approval effect when answering questions. Future studies may consider a more rigorous design to arrive at more generally efficient conclusions. Finally, this study was conducted in a sample of Chinese college students, which may have cross-cultural inconsistencies, suggesting that similar studies can be conducted in other types of samples in the future.

8. Significance

Despite these limitations, this study is the first to explore the internal connections and mechanisms among IU, anxiety, coping styles, and resilience in the context of Chinese culture, taking freshmen as the research objective.

9. Conclusion

1. Intolerance of uncertainty is positively associated with anxiety.
2. The mediating role of coping style between intolerance of uncertainty and anxiety.
3. Resilience moderated the effect of negative coping style on anxiety.

Data availability statement

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

Ethics statement

The studies involving human participants were reviewed and approved by Research Ethics Committee of Jiangxi University of Chinese Medicine. The patients/participants provided their written informed consent to participate in this study.

Author contributions

TW and SX: conceptualization, methodology, validation, writing—review and editing, and supervision. LJ, TL, and XZ: investigation and writing—original draft preparation. SX, LJ, and TL: data analysis and models conceptualization. All authors have seen, wrote, approved the manuscript, and revised the manuscript.

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Conflict of interest

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

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Emotional distress and burnout at a fever clinic in China: Comparison between different periods of COVID-19

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Background: Frontline healthcare workers (FHWs) experienced psychological stress and heavy workload during COVID-19 pandemic. This study examined the psychological symptoms and occupational burnout of FHWs in a fever clinic during different periods of the pandemic.

Methods: A cross-sectional survey of FHWs in the fever clinic of a tertiary hospital was carried out during both the outbreak period and regular period of COVID-19. Psychological measurement instruments including Generalized Anxiety Disorder 7-item, the 9-Question Patient Health Questionnaire, the Maslach Burnout Inventory-Human Service Survey, and the General Self-Efficacy Scale were used to evaluate anxiety, depression, burnout, and self-efficacy, respectively. The correlation between clinical variables was explored.

Results: A total of 162 participants were involved in this study, including 118 FHWs during the outbreak period (Group 1) and 44 FHWs during the regular period (Group 2). Anxiety symptoms were more prevalent in Group 2 (x^2=27.477) while depressive symptoms were significantly more prevalent in Group 1 (x^2=69.538). Burnout rate was higher in Group 2 (x^2=29.526). Self-efficacy was higher in Group 1 (t=3.194). Burnout was positively correlated with anxiety symptoms (r^2=0.424) and negatively correlated with self-efficacy (r^2=−0.312).

Conclusion: Anxiety, depressive symptoms and burnout were prevalent in FHWs during different periods of the COVID-19 pandemic. There is a tendency to be less depressed, but more anxious and burned out over time, although the severity of the pandemic is decreasing. Self-efficacy may be an important factor in protecting FHWs from occupational burnout. Support and intervention plans for FHWs should be made at the institutional level.

KEYWORDS

COVID-19, burnout, healthcare workers, China, anxiety, depression

1. Introduction

Since December 2019, the COVID-19 pandemic has spread rapidly in China and around the world, becoming a public health emergency of global concern ([1]). Especially in the early days, the COVID-19 pandemic has put enormous pressure on governments and people around the world. The general public has had to cope with acute stress due to

the uncertain source of disease, rapid transmission, and complexity of treatment (2). To date, the COVID-19 pandemic remains a major global public health issue and continues to pose a threat to all of humanity (3). Despite the increasing rate of vaccination against the virus, problems such as virus mutation, virus transmission and increased infection capacity remain prominent.

Every individual affected by the epidemic is facing great mental stress. WHO has identified addressing mental health needs as an essential part of the response to the COVID-19 pandemic (4), such as addressing public emotional reactions and stress among health workers. Medical staff were confronted with a variety of psychological stresses, including the risk of infection, high-intensity work stress, frustration at the lack of effective treatment, and loneliness in isolation (5). In the early days of the COVID-19 pandemic in China, a study of healthcare workers (HWs) in Wuhan (6) found that 50.4% of HWs exposed to the pandemic had clinically significant depressive symptoms. In another study of HWs in Beijing (7), 12.2% were depressed. Other studies around the world have found that during the first wave of the pandemic, HWs were under great mental stress and their mental health was significantly affected. In a study in Ethiopia (8), 58, 16.3, and 30.7% of HWs experienced moderate or severe stress, depression, and anxiety symptoms during the pandemic, and HWs' poor coping was related to these psychological impairments, suggesting the need for psychological intervention for HWs. A study in Switzerland (9) found that 70% of HWs reported significant emotional stress and increased anxiety during the first wave of the pandemic, with a lack of protective equipment being an important source of stress. In the severely affected areas, the number of patients increased rapidly, far exceeding normal workload, and there was usually a serious shortage of personnel and supplies. The imbalance between resources and needs was first felt by frontline healthcare workers (FHWs). As the group most exposed to the disease, FHWs had a higher prevalence of anxiety, depression, and stress-related symptoms than the general public (10). Previous reviews of the psychological status of medical personnel in infectious disease outbreaks also found consistent evidence that gender, nurse occupation, and frontline working status are clear risk factors for psychological stress (11, 12), suggesting that psychological support for medical personnel needs to pay more attention to the female frontline nurse population.

Professional burnout was first described in 1975 by Freudenberger (13) on staff in a free medical clinic. Characteristics of occupational burnout in the context of physical and behavioral symptoms include increased anger, frustration, excessive rigidity and inflexibility in practice, and the appearance of depression characteristics. Those who are prone to burnout are often dedicated and committed to their profession. Burnout is not an acute condition but rather a chronic culmination of the effects of unsolvable, long-term work stress, professional responsibilities and the work environment. The three dimensions of burnout syndrome are emotional exhaustion, depersonalization or cynicism, and a decreased sense of personal accomplishment (13–15). Research indicates that burnout in healthcare professionals can lead to negative attitudes toward day-to-day work and a reduced focus on patients, which hinders medical

safety and quality, and has serious consequences for the worker's personal life (16–18). Professional burnout of FHWs during the COVID-19 pandemic has been reported in some studies. A study reported high rates of insomnia, burnout, and functional impairment among healthcare providers in Jordan during the first year of the COVID-19 pandemic (19). A study during the pandemic in Japan (20) found that more than 40% of nurses and more than 30% of radiological technicians and pharmacists met the criteria for occupational burnout. A study in Belgium (21) found that nearly half of HWs working on the front lines in the first wave of COVID-19 had significant occupational exhaustion, 28.8% had moderate or higher depression, 41.8% had moderate anxiety or higher, and 25.1% had moderate or higher stress, with increased workload and perceived support associated with these adverse outcomes. Researchers from Korea found that burnout had a direct effect on depression, anxiety, and physical and mental health in HWs (22). Combined, these factors can also pose a significant risk to the quality of patient management.

By 2023, many countries, including China, have adopted regular control measures to reduce the impact of the pandemic on the general public. However, FHWs were inevitably constantly faced with COVID-19. Recently, with more relaxed control measures adopted in China, the number of COVID-19 cases is expected to increase, possibly leading to more work-related stress in FHWs. To date, there have been few studies examining the current psychosomatic health status of FHWs during the regular period of the pandemic. In this study, we examine the psychological symptoms and occupational burnout of FHWs in a fever clinic during both the outbreak period and the regular period, in order to provide more evidence and help improve the psychosomatic intervention of FHWs during the pandemic.

2. Materials and methods

2.1. Study design and participants

This study was designed as a single-center cross-sectional study. All FHWs working in the fever clinic of a tertiary hospital in Beijing during the designated time period were considered eligible for this study, which included the COVID-19 outbreak period (January 2020 to April 2020, group 1) and the regular period (October 2021 to November 2021). Two researchers (JJ and HJ) contacted FHWs by telephone and invited them to participate. Of the 170 FHWs invited, 162 agreed to join the study. The enrollment of participants is shown in Figure 1. Participants were divided into two groups based on when they worked in the fever clinic, and there was no overlap in participants. The survey was conducted by telephone during the COVID-19 outbreak (Group 1) or *via* an online questionnaire during the regular period (Group 2). Demographic and psychological data were collected.

2.2. Ethical considerations

The study was reviewed and approved by the ethics committee of Peking Union Medical College Hospital (approval number S-K1045),

FIGURE 1
Flowchart of study subjects.
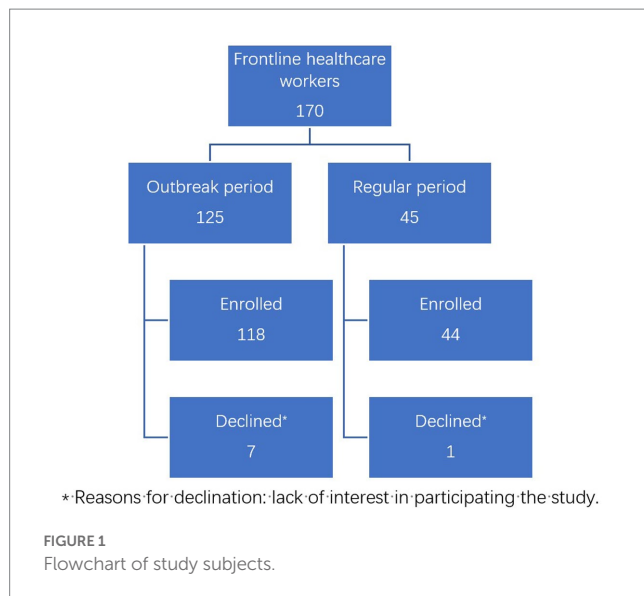
which is located in Beijing, China. Oral informed consent was obtained from each participant.

2.3. Psychological measurement instruments

Chinese validated versions of the following questionnaires were used to evaluate participants' psychological symptoms: Generalized Anxiety Disorder 7-item (GAD-7) (23), Patient Health Questionnaire 9-item (PHQ-9) (24), Maslach Burnout Inventory-Human Service Survey (MBI-HSS) (25, 26), and General Self-Efficacy Scale (GSES) (27, 28).

GAD-7 consists of seven questions that assess the frequency of anxiety symptoms. Each question is scored from 0 (not at all) to 3 (almost every day), giving a total score of 0 to 21. Anxiety symptoms are defined as a GAD-7 score ≥ 5. A total score of 5–9, 10–14, and ≥ 15 are considered mild, moderate, and severe anxiety symptoms, respectively.

PHQ-9 consists of nine questions assessing the frequency of depressive symptoms. Each question is scored from 0 (not at all) to 3 (almost every day), summing up to a total score of 0 to 27. Depressive symptoms are defined as a PHQ-9 score ≥ 5. A total score of 5–9, 10–14, and ≥ 15 are considered mild, moderate, and severe depressive symptoms, respectively.

MBI-HSS is a 22-item instrument covering three aspects of burnout, emotional exhaustion (EE), depersonalization (DP), and personal accomplishment (PA). Each item has a 7-point Likert scale from "never" or 0 to "daily" or 6. We defined a 27 or higher EE score, a 10 or higher DP score, or a 33 or lower PA score as burnout for participants.

GSES is a 10-item self-rating scale that assesses the strength of an individual's belief in his or her own ability to respond to novel or difficult situations and to cope with any associated obstacles or setbacks. For each item, there are four response choices from 'not at all true', which scores 1, to 'exact true', which scores 4. The scores for each of the 10 items are summed up to give a total score. The higher the score, the greater the individual's generalized sense of self-efficacy.

2.4. Statistical analyses

All statistical analyses were performed using IBM SPSS Statistics 21.0.0.0. (IBM Corp., Armonk, NY, United States). Quantitative variables are described as mean $\pm$ standard deviation or median (interquartile range [IQR]) based on the normality of the variable. Categorical variables were described as frequencies (percentages). The Student's t-test was used to compare the two groups for continuous variables. The Chi-square test was used to compare the distributions of categorical variables among the groups. The correlation between clinical variables was tested using Spearman's correlation test. A value of $p < 0.05$ was considered statistically significant. This study was designed to search for clinical associations; therefore, only exploratory analyses are presented.

3. Results

A total of 162 participants completed the questionnaire, including 60 (37.0%) doctors, 92 (56.8%) nurses and 10 (6.2%) laboratory or radiology technicians (Table 1). The majority (71.0%) were female. Participants had an average age of 31.1 ± 6.5 years. Group 1 (G1) consisted of 118 FHWs who worked in the fever clinic during the outbreak period, while Group 2 (G2) contained 44 FHWs during the regular period. There were no significant differences in age, sex, and occupation (physician, nurse, or technician) between G1 and G2.

Anxiety symptoms were more prevalent in G2 (11.0% vs. 47.7%, $x^2 = 27.477$, $p < 0.001$) while depressive symptoms were significantly more prevalent in G1 (97.5% vs. 43.2%, $x^2 = 69.538$, $p < 0.001$). In G1, the mean score of GAD-7 was 0 (IQR 0–2). Nine (7.6%) participants had mild anxiety symptoms (GAD-7 score 5–9) and four (3.4%) had moderate symptoms (GAD-7 score 10–14). G2 had a mean score of 4.5 (IQR 2–9) in GAD-7. There were 16 (36.4%) participants in G2 with mild anxiety symptoms and 5 (11.4%) participants with moderate anxiety symptoms. None of the participants in either group had severe anxiety symptoms (GAD-7 score > 15). With depressive symptoms, G1 and G2 had mean PHQ-9 scores of 9 (IQR 7–10) and 4 (IQR 1–7). In G1, the number of participants with mild (PHQ-9 score 5–9), moderate (PHQ-9 score 10–14), and severe (PHQ-9 score ≥ 15) depressive symptoms were 84 (71.2%), 25 (21.2%), and 6 (5.1%) respectively. In G2, 15 (34.1%) participants had mild depressive symptoms, 2 (4.5%) had moderate symptoms, and another 2 (4.5%) had severe symptoms.

Occupational burnout rate was significantly higher in G2 than in G1 (24.6% vs. 72.7%, $x^2 = 29.526$, $p < 0.001$). The three factors of burnout, emotional exhaustion (4.2% vs. 43.2%), depersonalization (10.2% vs. 54.5%), and personal accomplishment (15.3% vs. 47.7%) all reflected a similar trend. Self-efficacy was significantly lower in G2 than in G1 (2.93 ± 0.54 vs. 2.60 ± 0.64, $t = 3.194$).

Depressive symptoms were positively correlated with age ($r^2 = 0.178$, $p = 0.025$) and anxiety symptoms ($r^2 = 0.164$, $p = 0.039$). Anxiety symptoms were positively associated with burnout ($r^2 = 0.424$, $p < 0.001$) and all three aspects of burnout (Figure 2), depressive symptoms ($r^2 = 0.164$, $p = 0.039$), and negatively associated with self-efficacy ($r^2 = -0.254$, $p = 0.001$). Burnout and self-efficacy were negatively correlated ($r^2 = -0.312$, $p < 0.001$, Figure 3), while both were not correlated with age, sex, or occupation. There was no significant

TABLE 1 Demographic information, psychological symptoms, burnout, and self-efficacy scores of participants.

	Group 1 (118)	Group 2 (44)	x^2/t	p
Age	31.47 ± 6.60	30.18 ± 6.02		
Sex				
Male	32 (27.1%)	15 (34.1%)		
Female	86 (72.9%)	29 (65.9%)		
Occupation				
Doctor	48 (40.7%)	12 (27.3%)		
Nurse	61 (51.7%)	31 (70.4%)		
Technician	9 (7.6%)	1 (2.3%)		
Psychological symptoms				
Anxiety symptoms (GAD-7 ≥ 5)	13 (11.0%)	21 (47.7%)	27.477	<0.001
Depressive symptoms (PHQ-9 ≥ 5)	115 (97.5%)	19 (43.2%)	69.538	<0.001
Burnout	29 (24.6%)	32 (72.7%)	29.526	<0.001
EE	5 (4.2%)	19 (43.2%)	36.734	<0.001
DP	12 (10.2%)	24 (54.5%)	34.577	<0.001
PA	18 (15.3%)	21 (47.7%)	17.151	<0.001
Self-efficacy	2.93 ± 0.54	2.60 ± 0.64	3.194	0.002

GAD-7, The Generalized Anxiety Disorder 7-item; PHQ-9, The 9-Question Patient Health Questionnaire; EE, emotional exhaustion; DP, depersonalization; PA, personal accomplishment.

FIGURE 2
Pearson correlation between anxiety symptoms and burnout.

FIGURE 3
Pearson correlation between self-efficacy and burnout.
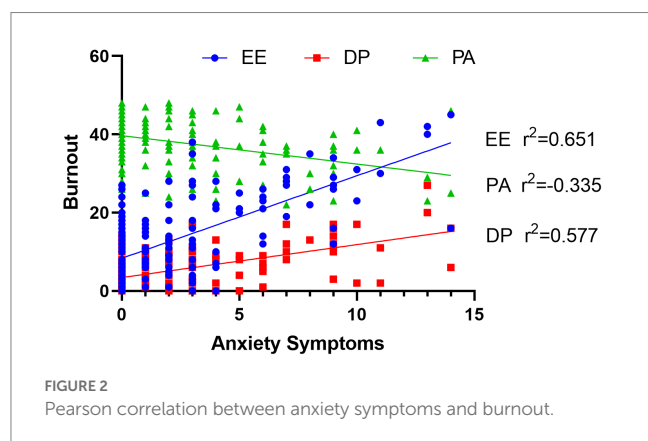
correlation between depressive symptoms and burnout ($r^2 = -0.101$, $p = 0.211$).

4. Discussion

As a global public health crisis, COVID-19 has particularly affected healthcare workers (29). In the early days of the pandemic, many researchers in China focused on the psychological stress of medical personnel and identified several possible contributing factors. Some suggested that during the outbreak, shortages of personal protective equipment (PPE), long working hours, and overwork were common factors affecting the stress levels of healthcare workers (3). In our colleagues' previous qualitative study (30), FHWs commonly reported nervousness and worrying symptoms, as well as insomnia and physical discomfort. Similar findings were found in several studies (31–34). In a systematic review and meta-analysis of the psychological impact of COVID-19 on Chinese healthcare workers in early 2020
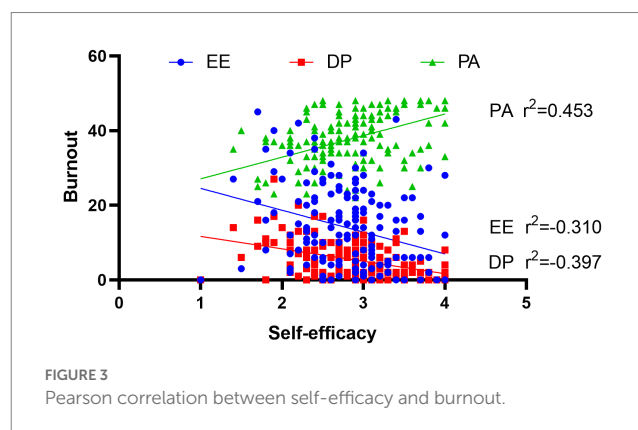
(12), pooled prevalence rates of anxiety, depression, and sleep disturbances were 17% (13–21%), 15% (13–16%), and 15% (7–23%), respectively. Tong et al. (35) reported the prevalence of anxiety and depression in FHWs during the outbreak period and regular period was 1.6 and 13.1% and 6.1 and 8.1%, respectively. In our study, the trend of "less depressed, more anxious" from outbreak to regular period was similar to Tong et al.'s findings, although the prevalence rates of both symptoms were higher in our study. The difference may result from different clinical settings and questionnaires used to evaluate anxiety and depressive symptoms.

Occupational burnout among medical personnel is often higher than in the general population (36). Since the start of the COVID-19 pandemic, studies of burnout among front-line and non-front-line HWs have shown a high burnout rate (20, 37–41), and these HWs often have more emotional distress. Factors related to HWs' burnout include female sex, less work experience, nurse occupation, and work location (37–41). Using the Effort-Reward Imbalance theory to explore the relationships between burnout and emotional distress, Zhang et al. (42) found that effort and over-commitment were

positively associated with depression and anxiety, reward was negatively associated with depression and anxiety, and buffered the harmful effect of effort/over-commitment on depression and anxiety. In our study, FHWs during the outbreak period had lower burnout rates and higher self-efficacy than their colleagues during the regular period. Considering the correlation between burnout and self-efficacy, it is possible that self-efficacy protects FHWs from occupational burnout.

To the general public, COVID-19 has become a constant stressor in the background. One segment of the population that is severely affected by this pandemic is the FHWs. Morioka et al. (43) proposed that some HWs continue to suffer from prolonged psychological distress during the regular period of the COVID-19 pandemic, which may lead to emotional symptoms and somatic discomfort. Risk factors for this include nurse occupation, underlying physical condition, and being prejudiced against due to involvement in COVID-19 healthcare. According to a review of retrospective studies on SARS and MERS (44), an event that occurs over a limited period—however severe—is less traumatic than chronic and prolonged stress over time with no end in sight. Professional identity as a caregiver also makes HWs vulnerable to stress. Yang et al. (45) reported 2,878 out of 15,531 (18.5%) FHWs experienced workplace violence during the outbreak period.

Occupational burnout among HWs is an important issue because it impairs medical quality and safety. Our study revealed the correlation between burnout and anxiety, the latter commonly present under chronic stress, which was found to be correlated with burnout as well (39). Depression and burnout have been considered as synonymous in some literature (46, 47), while others argue that they are categorically distinct (48, 49). We did not find significant correlations between depressive symptoms and burnout in the participants. A recent meta-analysis (48) reported only moderate correlations between scores on burnout and depression measures. One possible explanation for the lack of correlation may be that the tool used to measure burnout in many studies, including this study, is MBI-HSS, which does not include any depressive symptoms (25, 26). Burnout and chronic stress are intertwined and form a vicious circle. Given the increasingly relaxed pandemic control measures and the increasing number of infected patients, FHWs are expected to embrace a wider range and greater intensity of stress. In future studies, follow-up studies on the psychosomatic status and occupational burnout trajectories of FHWs should be continued.

Quoting Dow et al. (50), a crisis – including the COVID-19 pandemic – should never be wasted. Our findings, like others, may provide evidence for tailoring support and intervention plans for FHWs. At the institutional level, there is a need to strengthen the protection and support of FHWs during the pandemic, but proactive prevention against possible psychological distress and occupational burnout should be equally or even more important. The role and function of each individual and the boundaries between roles should be clearly defined (17), and the rotation work pattern should be mandatory to ensure sufficient "off time," "worry-free time" or "self-care time" for each individual (51). In the routine training of HWs, attention should be paid to reserving personnel in case of special periods such as COVID-19 to be mobilized at any time. At the same time, if there is a shortage of PPEs, priority should be given to ensuring supply at the frontline (9). Psychologically, FHWs should be provided with the necessary psychological support at the

individual level, such as counseling and support groups (8, 9, 21). In daily work, enhancing the psychological resilience of HWs also helps to cope with professional burnout (51). Our colleagues have previously reported that in some FHWs, experience at the frontline has led to a more positive assessment of one's self, and the belief that occupation and life are purposeful and meaningful (30). This may be a sign of good psychological resilience, which affects one's perception of setbacks (52). It is also important to fully recognize and reward FHWs for their dedication. At the level of government management, short-term responses to the pandemic crisis need to address gaps in the distribution of medical resources in different regions and appropriately increase support for areas lacking medical resources. Since the outbreak of COVID-19, the Chinese Health Commission has organized the transfer of HWs from areas with more medical resources to less developed areas (53). It is important to note that while this measure directly relieved local HW pressures, transferred FHWs faced more complex stressors, such as adaptation needs (54). Long-term measures should focus on further strengthening medical education and enhancing the flexibility and adaptability of HWs.

Our research has some limitations. First, the study was designed to be single-centered, which may limit its generalizability. Second, although we were able to include participants from different periods of the COVID-19 pandemic, we did not follow the same group to see the trend in their emotional distress over time. However, this limitation was compensated for by the fact that the two groups matched in demographic characteristics. Third, we were unable to obtain more sociodemographic information from participants, which may be confounding factors for emotional distress and occupational burnout. Finally, similar to most COVID-19 studies, our study used self-report questionnaires about psychological symptoms rather than diagnostic interviews for mental disorders, which may be affected by recall bias. In future studies, it is recommended to assess factors and coping mechanisms for burnout and psychological symptoms among HWs. It is also important to compare research findings from different cultures and socioeconomic backgrounds.

In conclusion, anxiety, depressive symptoms and burnout are prevalent in FHWs during both the outbreak period and the regular period of COVID-19. There is a tendency to be less depressed, but more anxious and burned out over time, although the severity of the pandemic is decreasing. Self-efficacy may be an important factor in protecting FHWs from occupational burnout. During the regular period of COVID-19, more attention and active interventions are still needed for the mental health and occupational burnout of healthcare workers.

Data availability statement

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

Ethics statement

The studies involving human participants were reviewed and approved by the Ethics Committee of Peking Union Medical College

Hospital. Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

Author contributions

WG, JC, XH, and JW conceived and designed the study. WG, JJ, JH, and YD collected the data. WG performed the statistical analyses. WG and JC wrote the first draft of the manuscript draft. All authors had access to the data, played a role in writing the manuscript, and commented on the posterior versions and approved the final manuscript.

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Conflict of interest

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

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Comparison of peripheral blood T, B, and NK lymphocytes between frontline medical workers for treating patients of COVID-19 and normal outpatient and emergency medical workers in China

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The outbreak of the novel coronavirus disease 2019 (COVID-19) has led to significant mental stress for frontline medical workers treating patients with confirmed COVID-19 in China. Psychological stress has an impact on the immune system. The number and percentage of lymphocyte subsets are standard indicators of cellular immune detection. Here, we reported the differences in CD3, CD4, CD8, CD19, and CD56 lymphocytes between 158 frontline medical workers and 24 controls from medical staffs of the outpatient and emergency departments. We found that frontline medical workers had significantly lower absolute values and percentages of CD19$^+$ B cells, especially in the female and the aged ≥40years subgroup. Stratification analysis showed that the absolute values of CD4$^+$ T cells were significantly lower in the aged <40years subgroup, while percentages of CD8$^+$ T cells were lower and percentages of CD56$^+$ NK cells were higher in the aged ≥40years subgroup. In summary, this study suggests paying more attention to frontline medical workers' mental health and immune function, and properly providing them with psychological interventions and measures of care.

KEYWORDS

COVID-19, psychology stress, frontline medical workers, immunity, mental health

1. Introduction

Novel coronavirus disease 2019 (COVID-19), caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), is prevalent worldwide (1). COVID-19 is highly contagious and seriously harmful. Globally, there were more than 516 million COVID-19 cases that had been confirmed as of July 10, 2022, and there had been about 6.25 million fatalities overall, according to a report from the World Health Organization (WHO).

The immune system is the main mechanism by which the body defends itself against harmful pathogens. Lymphoid stem cells can differentiate into three main types of mature lymphocytes: B

lymphocyte, T lymphocyte, and natural killer (NK) cell lineages (2). Measured as non-specific blood-validated markers, white blood cells (WBCs), and immune cell subsets play a role in the indication of immune function (3). The immune system is regulated by the neuroendocrine system. Previous studies have proved that acute stress, chronic stress, and job burnout have varying degrees of adverse effects on humoral immune function, NK cell, T lymphocyte function, and other immune parameters (4, 5). A research on the occupational health status of emergency physicians in Japan showed that among overworked doctors, there were noticeable disparities in lymphocyte counts, CD4$^+$ T cell counts, and NK cell activity; the low NK cell activity partially reflected the severity of the exhaustion brought on by the doctors' overwork (6). Several studies of nurses performing shift work have shown that fatigue leads to lower NK cell activity and the deleterious effects on NK cell function depended on the degree of fatigue (7, 8). In a hospital in Guangxi, Cui et al. studied the immunological function of female oncology nurses and discovered that C3, C4, CD4$^+$, and CD8$^+$ T cells were substantially correlated with symptoms of burnout (9). In addition, a study of non-healthcare workers also found that the percentage of CD56$^+$ cells decreased significantly when either the working hours per week increased or the sleep time decreased (10).

It is the substantial mental pressure brought to the frontline medical workers in China by the outbreak of the COVID-19 that attracts people's attention. Survey results show a significant prevalence of symptoms of depression, anxiety, and distress among frontline healthcare professionals (11). A prospective study found that the workload of frontline medical workers is much larger than before participating in the fight against the COVID-19 pandemic. At the same time, various negative factors such as heavy assignments, social and professional isolation, a lack of time for physical activity and meditation, and compassion fatigue were reported among doctors, bringing them mental and psychological stress (12). Compared to non-frontline medical workers, frontline healthcare workers appear to experience much more anxiety, stress, and sleeplessness (11, 13). Furthermore, an immunological study has revealed that the lymphocyte count and lymphocyte ratio in the peripheral blood of frontline medical workers increased significantly after struggling with COVID-19, but gradually returned to normal several months later (14).

In the face of the above-mentioned unfavorable factors, we predict that the immune system of frontline medical workers will be affected, which is reflected in the fact that the lymphocyte subsets count and proportion are different from those of outpatient and emergency physicians in hospitals. However, the difference remains unclear. Here, we reported the differences of CD3, CD4, CD8, CD19, and CD56 lymphocytes between 158 frontline medical workers who returned to Changchun after supporting Wuhan and 24 outpatient and emergency physicians and nurses in the China-Japan Union Hospital of Jilin University during the same period. This study can provide a theoretical basis and ultimately help to provide appropriate psychological intervention for frontline medical workers.

2. Materials and methods

2.1. Participants

The present research involved 158 frontline medical workers from China-Japan Union Hospital who had given healthcare assistance to Wuhan COVID-19 patients as experimental group for 3 months, and 24 medical staffs of the outpatient and emergency department during the same period as control group. The exclusion criteria were as follows: (I) autoimmune disorders; (II) individuals suffering from tuberculosis, hepatitis B virus (HBV), AIDS (HIV), or hepatitis C virus (HCV); (III) patients had been treated with drugs that affect the immune system within 3 months; (IV) patients infected or had been infected with COVID-19. In addition, all subjects had not mental and psychological conditions such as depression and anxiety.

2.2. Apparatus and reagents

The antibody detection kit used for immunophenotype contains antibody Panel A (CD45-FITC/CD4-RD1/CD8-ECD/CD3-PC5 antibodies, LOT, 7536331) and antibody Panel B (CD45-FITC/CD56-RD1/CD19-ECD/CD3-PC5 antibodies, LOT, 7580257). Using a five-color FC 500 flow cytometry (Beckman Coulter) for sample collection.

2.3. Data collection and sampling processing

The demographic data were collected from the electronic health examination, including age, sex, occupation, and medical history. About 2 mL of blood was extracted from each fasting participant in EDTA-K2 tubes. Take 50 μL from anticoagulant whole blood samples and put them into two centrifuge tubes, marked as tubes A and B. Put 10 μL of antibody A and 10 μL of antibody B into two tubes, respectively. After stirring and mixing, incubate the cells in the darkness at ambient temperature for 15 min. Next, add 100 μL FCM Lysing solution to each tube. Incubate again for 10 min, then add 1 mL PBS and centrifuge at 1,500 r/min for 5 min. Lastly, discard the supernatant and add 500 μL PBS before detection by the flow cytometry within 24 h. Data were analyzed with Shortcut to CXP or Kaluza analysis software. Absolute values (cells/μL) = The absolute values of lymphocyte (cells/μL) × percentages of the lymphocyte subsets of interest × 1,000.

2.4. Statistical analyses

All statistical analyses were performed using data analysis software SPSS 26.0. Continuous variables were presented as mean ± SD, and units were expressed in the number of cells per microliter (cells/μL). The differences between the experimental and control groups, as well as those between frontline workers with different sexes or ages, were examined using the Student's t-test. The significance threshold was $p = 0.05$.

3. Results

3.1. Demographic characteristics

Hundred and fifty eight front-line frontline healthcare professionals in total, along with 24 controls, were enrolled. Among

158 frontline workers, 37 were male and 121 were female. The average age of 158 frontline workers was 34.3 ± 5.8 years old, ranging in age from 23 to 53. Among 24 medical workers from normal outpatient and emergency departments, four were male and 20 were female. The age of 24 controls range from 28 to 53 years old and the mean age was 42.4 ± 8.8 years old. The demographic characteristics of all subjects are shown in Table 1.

3.2. Comparison of absolute values and percentages of lymphocyte subsets between experimental and control groups

Means, standard deviations, and percentages of lymphocyte subsets are shown in Table 2. The relative frequencies of each subpopulation in relation to the overall lymphocyte population are expressed as percentage. Compared with control group, absolute values and percentages of CD19+ B cells were significantly lower in experimental group (shown in Figure 1A). Stratification analysis based on gender and age showed that absolute values and percentages of CD19+ B cells were significantly lower only in the female subgroup and the aged ≥40 years subgroup. Absolute values and percentages of CD56+ NK cells were higher in experimental group, but the difference was not statistically significant. Compared with control group, stratification analysis based on age showed that percentages of CD56+ NK cells were significantly higher in the aged ≥40 years subgroup (shown in Figure 1B). Absolute values and percentages of CD4+T cells and CD8+T cells were lower in the experimental group, but the difference was not statistically significant. Stratification analysis based on age showed that absolute values of CD4+ T cells were significantly lower in the aged <40 years subgroup, while percentages of CD8+ T cells were significantly lower in the aged ≥40 years subgroup (shown in Figure 1C).

3.3. Gender distribution of lymphocyte subsets in experimental group

Gender distribution of lymphocyte subsets in experiments are shown in Table 3. Absolute values of lymphocytes and CD3+ T cells were significantly lower in the female subgroup ($1,977 \pm 527$ and $1,396 \pm 402/\mu L$), compared with the male subgroup ($2,275 \pm 437$ and $1,553 \pm 371/\mu L$). Likewise, absolute values of CD8+ T cells, CD19+ B cells and CD56+ NK cells were significantly lower in the female subgroup (532 ± 194, 207 ± 79, and $271 \pm 168/\mu L$), compared with the male subgroup (608 ± 189, 246 ± 84, and $343 \pm 152/\mu L$). Besides, the value of CD4+/CD8+ was higher in the female subgroup (1.49 ± 0.65) when compared with the male subgroup (1.43 ± 0.68), but the difference was not statistically significant.

3.4. Age distribution of lymphocyte subsets in experimental group

Age distribution of lymphocyte subsets in experiments are shown in Table 4. Absolute values of CD8+ T cells, percentages of CD3+ T cells and CD8+T cells were significantly lower in the aged ≥40 years subgroup ($463 \pm 209/\mu L$, $63.8 \pm 10.1\%$, and $22.9 \pm 7.3\%$), compared with the aged <40 years subgroup ($563 \pm 190/\mu L$, $71.0 \pm 7.0\%$, and $27.6 \pm 6.7\%$). However, absolute values and percentages of CD56+ NK cells were significantly higher in the aged ≥40 years subgroup ($381 \pm 284/\mu L$ and $17.6 \pm 9.1\%$), compared with the aged <40 years subgroup ($274 \pm 136/\mu L$ and $13.3 \pm 5.7\%$).

4. Discussion

This study reported the changes in absolute values and percentages of T lymphocytes and their subpopulations, as well as B lymphocytes and NK cells of frontline medical workers for treating patients of COVID-19 compared to normal outpatient and emergency physicians. We found that frontline medical workers had significantly lower absolute values and percentages of CD19+ B cells, especially in females and aged ≥40 years subgroup. Stratification analysis showed that the absolute values of CD4+ T cells were significantly lower in the aged <40 years subgroup, while percentages of CD8+ T cells were lower and percentages of CD56+ NK cells were higher in the aged ≥40 years subgroup. Besides, we found that the changes were more obvious in females and the aged ≥40 years among frontline medical workers. Furthermore, no medical workers had been identified to be infected with COVID-19 or to be suffering from mental disorder.

The outbreak of COVID-19 has brought a series of psychological and spiritual stress to frontline medical workers (11, 15). Zhang et al. found that unlike non-healthcare staffs, healthcare staffs gained a higher prevalence of insomnia, anxiety, and depression symptoms (16). And Lai et al. reported that depression represented the highest at 50.4% of the total number of healthcare workers, while anxiety symptoms and insomnia accounted for 44.6% and 34.0% of the total number of healthcare workers, respectively (1). A study in Ecuador also reported that 66% of the subjects that manifested psychological distress, especially women with COVID-19 symptoms and previous exposure to infected patients or objects (17). These studies show us that frontline medical workers have huge psychological stress. The sympathetic nervous system and the hypothalamic–pituitary–adrenal axis, which are influenced by mental distress, that upregulate the levels of catecholaminergic neurotransmitters and corticosterone, leading to active immune responses and leukocytes redistribution, revealed by prior research (18–21). We suggest that the changes in the absolute values and proportions of immune cells may be caused by a series of psychological stress, and such changes may increase the risk of contracting the coronavirus or other diseases, such as inflammatory bowel disease (22). In addition, being in a state of psychological stress for a long time is not conducive to dealing with work affairs and serving patients. Therefore, more attention should be paid to the mental health and immunity level of frontline workers, and appropriate psychological interventions should be provided.

B lymphocytes participate in the process of clearing pathogens by secreting a variety of antibodies, such as IgM, IgG, etc. (23). In addition, B lymphocytes can also function without antibodies and play

TABLE 1 Characteristics of participants.

Group	n	Gender		Age (year)
		Male	Female	
Controls	24	4	20	42.4 ± 8.8
Experiments	158	37	121	34.3 ± 5.8

TABLE 2 The comparison between experimental group and control group (Mean±SD, cells/μL).

Parameters	Age/gender	Control group	Experimental group
Lymphocytes		2,175 ± 475	2,047 ± 522
	Male	2,243 ± 623	2,275 ± 437
	Female	2,162 ± 460	1,977 ± 527
	<40 years	2,348 ± 483	2,042 ± 491
	≥40 years	2,052 ± 446	2,077 ± 707
CD3+		1,525 ± 368	1,433 ± 399
	Male	1,679 ± 521	1,553 ± 371
	Female	1,494 ± 339	1,396 ± 402
	<40 years	1,676 ± 409	1,451 ± 381
	≥40 years	1,417 ± 305	1,316 ± 497
CD4+		827 ± 224	740 ± 261
	Male	939 ± 296	782 ± 289
	Female	805 ± 209	727 ± 252
	<40 years	905 ± 248	744 ± 244 ※
	≥40 years	771 ± 196	714 ± 363
CD8+		585 ± 153	549 ± 195
	Male	579 ± 199	608 ± 189
	Female	586 ± 148	532 ± 194
	<40 years	610 ± 131	563 ± 190
	≥40 years	567 ± 169	463 ± 209
CD19+		284 ± 104	216 ± 82 ※
	Male	198 ± 18	246 ± 84
	Female	301 ± 106	207 ± 79 ※
	<40 years	261 ± 88	215 ± 81
	≥40 years	300 ± 114	227 ± 88 ※
CD56+		275 ± 107	288 ± 166
	Male	282 ± 105	343 ± 152
	Female	274 ± 110	271 ± 168
	<40 years	316 ± 95	274 ± 136
	≥40 years	246 ± 108	381 ± 284
CD4+/CD8+		1.46 ± 0.40	1.47 ± 0.65
	Male	1.64 ± 0.12	1.43 ± 0.68
	Female	1.42 ± 0.43	1.49 ± 0.65
	<40 years	1.49 ± 0.30	1.44 ± 0.62
	≥40 years	1.43 ± 0.47	1.73 ± 0.8
CD3+%		70.1 ± 5.7	70.0 ± 7.8
	Male	74.5 ± 3.6	68.1 ± 8.2
	Female	69.2 ± 5.7	70.6 ± 7.6
	<40 years	71.3 ± 7.5	71.0 ± 7.0
	≥40 years	69.2 ± 4.2	63.8 ± 10.1
CD4+%		37.8 ± 5.0	36.0 ± 7.6
	Male	41.6 ± 1.9	34.1 ± 9.2
	Female	37.1 ± 5.1	36.6 ± 6.9

(Continued)

TABLE 2 (Continued)

Parameters	Age/gender	Control group	Experimental group
	<40 years	38.2 ± 4.3	36.3 ± 7.0
	≥40 years	37.6 ± 5.5	34.0 ± 10.5
CD8+%		27.2 ± 5.3	27.0 ± 7.0
	Male	25.6 ± 2.8	26.7 ± 6.6
	Female	27.5 ± 5.7	27.1 ± 7.1
	<40 years	26.4 ± 5.6	27.6 ± 6.7
	≥40 years	27.7 ± 5.2	22.9 ± 7.3 ※
CD19+%		13.2 ± 4.4	10.7 ± 3.4 ※
	Male	9.3 ± 2.5	10.9 ± 3.2
	Female	13.9 ± 4.4	10.7 ± 3.5 ※
	<40 years	11.2 ± 3.9	10.6 ± 3.3
	≥40 years	14.6 ± 4.4	11.4 ± 4.3 ※
CD3-CD56+%		12.6 ± 4.2	13.9 ± 6.4
	Male	12.6 ± 4.3	15.2 ± 6.5
	Female	12.6 ± 4.3	13.5 ± 6.3
	<40 years	13.4 ± 3.5	13.3 ± 5.7
	≥40 years	12.0 ± 4.7	17.6 ± 9.1 ※

※ $p < 0.05$.

an important role in immune system development and maintenance (24). When the body is under appropriate stress, the brain can affect the formation of plasma cells and regulate humoral immunity by activating the spleen via the brain-spleen axis (25–28). However, chronic stress caused reduction in circulating B cells, T cells, and large granular lymphocytes and decreased natural killer cell activity (28–30). In this study, the absolute values and proportions of CD19+ B cells in the frontline medical workers were significantly reduced. This may be due to the long-term busy and stressful working environment, which inhibited humoral immunity.

Many studies showed that there are sex differences in stress responses (31). In the face of stressors, testosterone is negatively correlated with cortisol levels in men, while estrogen in women stimulates the output of the HPA axis (21). Women responded to acute stressors in a proinflammatory fashion but experienced greater suppression of the immune system under chronic stress than men (32). In the current study, the changes in immune cells of frontline medical workers were more obvious in women, and the values and proportions of some lymphocyte subsets were lower than those of males in the same period, which may be more susceptible to disease by contrast. Previous studies showed that chronic stress reduces the values and proportion of nature killer cells (10, 33). The present study found that the proportion of CD56+ NK cells in the aged ≥40 years subgroup was significantly increased, and the absolute value was increased but there was no significant difference. The inconsistency of these results may be attributed to differences in the inclusion criteria, sample size, age distribution, etc. of the participants.

The limitations of our study mainly include screening criteria, sample size, and detection content. First of all, we did not conduct self-administered questionnaires and other methods on frontline medical workers before the research to assess their psychological
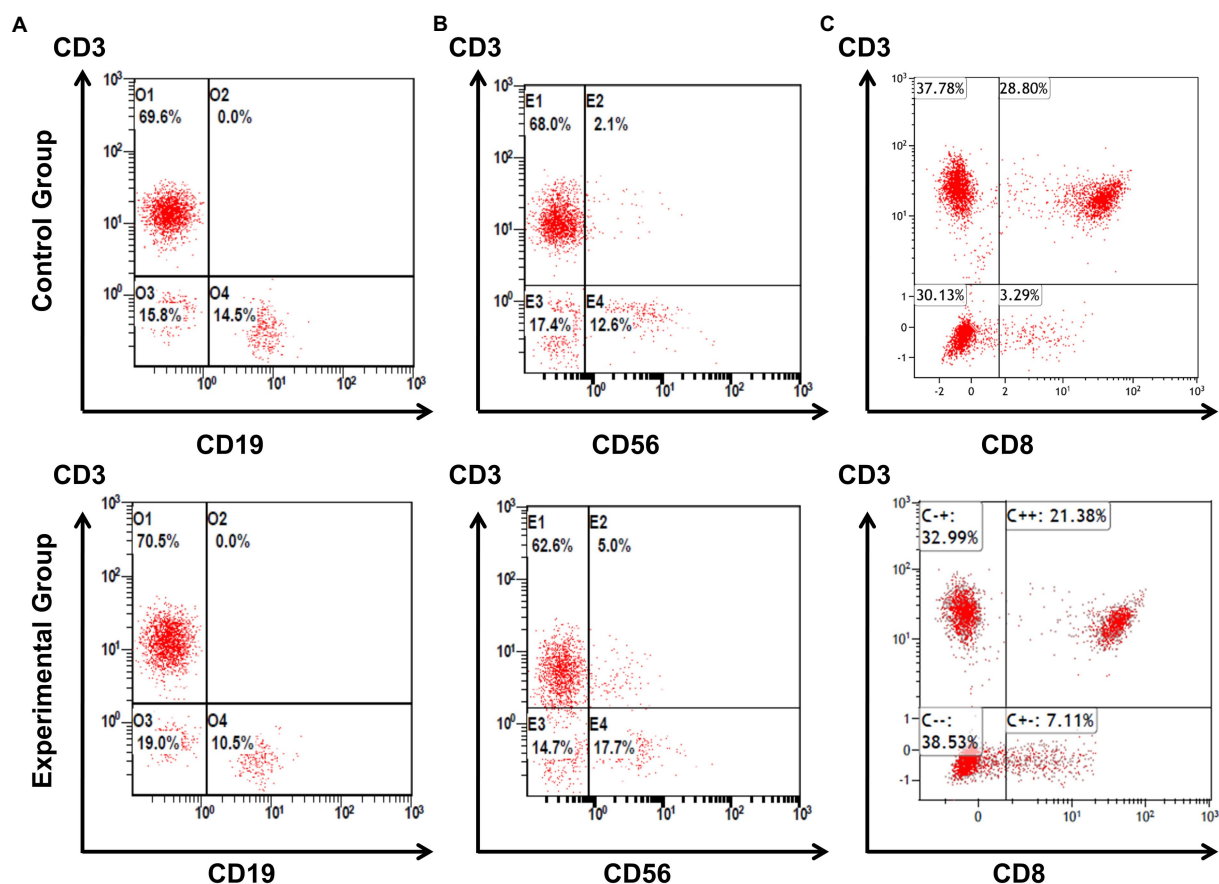
FIGURE 1
The main differences of percentages of lymphocyte subsets between experimental and control group. Frontline medical workers for treating patients of COVID-19 had significantly lower percentages of CD19+ B cells compared to control group, the representative results of flow cytometry are shown as line **(A)**. Compared with control group, stratification analysis showed that the percentages of CD56+ NK cells were higher in the aged ≥40years subgroup, the representative results of flow cytometry are shown as line **(B)**. Stratification analysis also showed that the percentages CD8+ T cells were lower in the aged ≥40years subgroup compared to control group, the representative results of flow cytometry are shown as line **(C)**.

TABLE 3 Absolute values and percentages of lymphocyte subpopulations in experimental group by sex (Mean±SD, cells/μL).

Parameter	Male (*n*=37)	Female (*n*=121)
Lymphocytes	2,275 ± 437	1,977 ± 527※
CD3+	1,553 ± 371	1,396 ± 402※
CD3+%	68.1 ± 8.2	70.6 ± 7.6
CD3+/CD4+	782 ± 285	727 ± 252
CD3+/CD4+%	34.1 ± 9.2	36.6 ± 6.9
CD3+/CD8+	608 ± 189	532 ± 194※
CD3+/CD8+%	26.7 ± 6.6	27.1 ± 7.1
CD19+	246 ± 84	207 ± 79※
CD19+%	10.9 ± 3.2	10.7 ± 3.5
CD3−/CD56+	343 ± 152	271 ± 168※
CD3−/CD56+%	15.2 ± 6.5	13.5 ± 6.3
CD4+/CD8+	1.43 ± 0.68	1.49 ± 0.65

※$p < 0.05$.

outcomes. Secondly, the sample of normal outpatient and emergency medical workers during the same period selected was relatively small. Thirdly, our study did not count neutrophils and

monocytes, which are the immune cells affected by chronic stress and can reflect the level of stress. Moreover, it would be more complete and helpful for this report if the function of T cells and NK cells, and common cytokine levels in the peripheral blood could be detected.

5. Conclusion

The results of the present study indicated that the changes of T lymphocytes and their subpopulations, as well as B lymphocytes and NK cells, were found in frontline medical workers providing support for Wuhan COVID-19 patients, especially in females and physicians over 40 years old. Those may be attributed to psychological stress such as work-related stress. As a result, we suggest paying more attention to the psychological health and immune function of frontline medical staffs, and properly providing them with psychological interventions and measure of care. Here are some of our suggestions: (I) Government departments should adjust and improve the current work arrangements to avoid overloading medical personnel. (II) It is necessary for the relevant authorities to give material support to protect medical workers' interests as soon as possible, such as the supply of protective

TABLE 4 Absolute values and percentages of lymphocyte subpopulations in Experiment group by age group (Mean±SD, cells/μL).

Parameter	Age<40years (n=137)	Age≥40years (n=21)
Lymphocytes	2,042 ± 491	2,077 ± 707
CD3$^+$	1,451 ± 381	1,316 ± 497
CD3$^+$%	71.0 ± 7.0	63.8 ± 10.1[※]
CD3$^+$/CD4$^+$	744 ± 244	714 ± 363
CD3$^+$/CD4$^+$%	36.3 ± 7.0	34.0 ± 10.5
CD3$^+$/CD8$^+$	563 ± 190	463 ± 209[※]
CD3$^+$/CD8$^+$%	27.6 ± 6.7	22.9 ± 7.3[※]
CD19$^+$	215 ± 81	227 ± 88
CD19$^+$%	10.6 ± 3.3	11.4 ± 4.3
CD3$^-$/CD56$^+$	274 ± 136	381 ± 284[※]
CD3$^-$/CD56$^+$%	13.3 ± 5.7	17.6 ± 9.1[※]
CD4$^+$/CD8$^+$	1.44 ± 0.62	1.73 ± 0.80

[※]$p < 0.05$.

materials and daily necessities. (III) Hospitals should routinely conduct physical examinations and make mental health evaluations for medical staffs.

Data availability statement

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

Ethics statement

The studies involving human participants were reviewed and approved by the Research Ethics Committee of China-Japan Union Hospital of Jilin University. The patients/participants provided their written informed consent to participate in this study.

Author contributions

WH and PM collected the literature and wrote the manuscript. XL edited the manuscript. YW and YZ wrote, conceived, and reviewed the manuscript critically. All authors contributed to the article and approved the submitted version.

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Conflict of interest

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

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COVID-19 pandemic-related depression and anxiety under lockdown: The chain mediating effect of self-efficacy and perceived stress

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Objective: In early March 2022, the highly contagious Omicron variant rapidly emerged in Shanghai. This study aimed to explore the prevalence and associated factors of depression and anxiety in isolated or quarantined populations under lockdown.

Methods: A cross-sectional study was conducted between May 12 and 25, 2022. The depressive and anxiety symptoms, perceived stress, self-efficacy and perceived social support in the 167 participants under isolated or quarantined were examined using the Patient Health Questionnaires-9 (PHQ-9), the Generalized Anxiety Disorder-7 (GAD-7), the Perceived Stress Scale-10 (PSS-10), the General Self-Efficacy Scale (GSES) and the Perceived Social Support Scale (PSSS). Data on demographic information were also collected.

Findings: The prevalence of depression and anxiety in isolated or quarantined populations was estimated to be 12 and 10.8%, respectively. Higher education level, being healthcare workers, being infected, longer duration of segregation and higher perceived stress level were identified as risk factors for depression and anxiety. Furthermore, the relationship between perceived social support and depression (anxiety) was mediated not only by perceived stress but also the chain of self-efficacy and perceived stress.

Conclusion: Being infected, higher education level, longer duration of segregation and higher perceived stress were associated with higher levels of depression and anxiety among isolated or quarantined populations under lockdown. The formulation of psychological strategies that promote one's perceived social support and self-efficacy as well as reduce perceived stress is supposed to be drawn.

KEYWORDS

COVID-19, depression, anxiety, perceived stress, self-efficacy, perceived social support

Introduction

The outbreak of coronavirus disease 2019 (COVID-19) was announced to constitute a public health emergency of international concern by the World Health Organization (WHO) on 30 January, 2020 (1), and it has continued to rampage globally up to now. Shanghai, the largest financial and economic hub of China, was placed under a citywide lockdown due to its worst COVID-19 outbreak caused by the highly contagious Omicron variant in early March 2022 (2). As of May 31, 2022, a total of 626,000 COVID-19 infections, including confirmed locally transmitted cases and asymptomatic carriers, were reported in Shanghai (3). The global public health should be alarmed by the increased transmissibility and immune evasive properties of SARS-CoV-2 variants.

Effective prevention and control of COVID-19 has been a health issue of grave concern worldwide (4). Measures such as lockdowns, isolation, quarantine and social distancing have been implemented by many countries and regions in reaction to the COVID-19 pandemic (5–7). There is no denying that these measures are acknowledged as practical containment strategies for the pandemic, but the negative impact of these measures on individuals, societies, and the economy should be considered with caution (8–10). Although isolation and quarantine are conceptually distinct, both involve the separation from normal populations and the restriction of movement to prevent or eliminate the spread of infection or contamination (11). A growing number of studies have confirmed that people who underwent isolation or quarantine during the COVID-19 pandemic were subjected to a tremendous psychological and physical burden, which gave rise to a wide variety of dramatic and long-lasting psychological distress, such as depression, anxiety, posttraumatic stress disorder, insomnia and high perceived stress (12–16). It has been documented by a global-scale study that the COVID-19 pandemic resulted in a remarkable increase in the prevalence and burden of major depressive disorder (a 28% increase) and anxiety disorders (a 26% increase) during 2020 (17), both of which ranked among the leading causes of the global burden of disease even before the COVID-19 pandemic (18). Moreover, a national study on the mental health impact of COVID-19 pandemic post-lockdown demonstrated a high prevalence of depression (39%) and anxiety (42%) in the adult US population (19). A systematic review revealed that the prevalence of anxiety and depression during the initial COVID-19 lockdown in the United Kingdom was 31 and 32%, respectively, showing a substantial increase compared with the prevalence of pre-pandemic (20). Consequently, the development of timely and effective psychological interventions for individuals in isolation or quarantine is a critical component of the COVID-19 management. There are growing appeals for prioritizing mental health from the very start to identify and protect vulnerable populations and enhance long-term resilience against future crises (21).

However, due to the current prioritization of limited medical resources for the containment of COVID-19 and the treatment of infected patients, obtaining adequate resources for mental health services remains to be a formidable challenge. Targeting psychological support with limited resources for diverse populations impacted by the COVID-19 pandemic is, therefore, of essential significance. Lazarus has proposed that cognitive appraisal mediates the relationship between stressors and emotional experience, which accounts for emotional responses varying from person to person even

under the same or similar conditions (22). Hence, developing psychological interventions that emphasize promoting individuals' personal resources and altering their negative cognitive appraisals may contribute to emotion regulation under public health emergencies such as the COVID-19 pandemic. In view of the circumstance of lockdown that may trigger social and emotional isolation, social support and self-efficacy are vital external and internal resources, respectively, that many researches have demonstrated their association with depression and anxiety (23–25).

Social support is a multidimensional concept characterized by the emotional, instrumental, and informational support from families, friends and important others (26), which was identified as a protective factor against depression and anxiety during the COVID-19 pandemic (12, 24). Further, a review on the association between social support and depression provided evidence for the protection of social support for depression across all ages (27). Unlike received social support, which is described as objective and specific assistance from social networks, perceived social support highlights more the subject perception and evaluation of the available resources and supports from social relations (28), which relates more tightly to cognition. Therefore, the current study focused on perceived social support to investigate how it exerts an effect on depression and anxiety among isolated or quarantined populations during the COVID-19 pandemic. Self-efficacy was defined as the belief in one's competence and efficiency to successfully tackle tasks by Bandura (29). Existing research have proved a negative correlation between self-efficacy and negative mental health outcomes resulted from COVID-19 pandemic, such as stress, depression, anxiety and fear (23, 30). It is suggested that higher self-efficacy can prevent poor psychological outcomes during COVID-19 pandemic (31). A full mediating effect of self-efficacy between social support and negative emotions (depression and anxiety) was also demonstrated in patients with prostate cancer (32). Furthermore, people under isolation or quarantine during the COVID-19 pandemic were confronted with stressors in diverse aspects, which tended to generate high level of perceived stress (33, 34). There was evidence that perceived stress worked as a mediator for longitudinal negative effects (containing depression and anxiety) of the COVID-19 lockdown (35). It has also been determined the potential role of perceived stress as a mediator between social support, self-efficacy (measured as coping self-efficacy) and depressive symptoms (36). In consequence, it is reasonable to suppose that improving one sense of perceived social support and self-efficacy, as well as reducing perceived stress will mitigate COVID-19-related psychological consequences of depression and anxiety under the COVID-19 pandemic.

Notwithstanding, no study to date, to our knowledge, has yielded the association among perceived stress, self-efficacy, perceived social support, depression and anxiety in isolated or quarantined population during the COVID-19 pandemic, specifically the mediating effects of self-efficacy and perceived stress. The primary objectives for this study were twofold: (1) to determine the prevalence and associated factors of depression and anxiety among the population isolated or quarantined under Shanghai lockdown; (2) to examine how perceived social support, self-efficacy and perceived stress affect the level of depression and anxiety, and to determine the potential mediating

effects. Previous literature on COVID-19 showed that demographic factors (i.e., age, gender and educational level), presence of family or pets, being infected or not and duration of isolation or quarantine were significantly correlated to depression and anxiety (23, 37, 38). Therefore, these variables were hypothesized as potential associated factors in this study. Further, it was hypothesized that self-efficacy and perceived stress mediated the association between perceived social support and the level of depression (anxiety).

Methods

Participants and procedure

This was a cross-sectional study conducted at a centralized isolation and treatment site under lockdown in Shanghai between May 12 and 25, 2022. During the survey period, approximately 1,000 individuals were isolated or quarantined at the site, including COVID-19-positive patients and healthcare workers caring for the patients. The sample size was calculated with α set as 0.05, β as 0.2, and the overall prevalence of mood disorders (depression and anxiety) estimated as 35%, which came from a nationwide large-scale survey of psychological distress among Chinese during the COVID-19 epidemic (39). Thereby, a minimum sample size of 151 was required in this study. The following inclusion criteria were adopted for the recruitment of eligible participants: (1) being isolated or quarantined at the isolation site during the Shanghai lockdown; (2) aged ≥18 years old; (3) normal ability of speech, comprehension and expression; and (4) volunteering to participate in the study. Respondents who had previously been diagnosed with mental illness or in serious physical condition were excluded.

To minimize the risk of cross-infection, the questionnaire survey was conducted on an online platform[1] *via* personal smartphone. Data collection fell primarily under the purview of a medical assistant with professional psychological training. All participants provided written or verbal informed consent prior to participation in the study after the medical assistant explained the nature of the study. It was an anonymous survey, but participants were asked to give their phone number voluntarily if they needed emotional or psychological support. Ethical permission for the study was granted by the Ethics Committee of Naval Medical University.

Measures

Participants were asked to complete a series of questionnaires. Information on demographic characteristic were collected from every participant: age, gender, education level, marital status, employment status, smoking status, presence of family or pets, current status (patients or healthcare workers), infection status and duration of segregation (isolation or quarantine). Furthermore, the levels of depression, anxiety, perceived stress, self-efficacy and perceived social support were measured using corresponding validated scales.

Depression

The Patient Health Questionnaire-9 (PHQ-9) (40) is a self-administered screening tool for depression, measuring to what extent an individual has been bothered by depressive symptoms during the past two weeks. The scale is consisted of 9 items, each on a Likert scale from "0" (not at all) to "3" (nearly every day), with an aggregate score ranging from 0 to 27. A higher score indicates higher level of depression and a cutoff score of 10 has been clinically validated for major depression with a sensitivity of 88% and a specificity of 88% [2]. This scale has been well applied in the general Chinese population with great reliability and validity (41). In the current study, a PHQ-9 score of 10 or higher was indicative of having elevated depressive symptoms (probable depression) and the Cronbach's α for internal consistency was 0.880.

Anxiety

Also with a focus on the past two weeks, the Generalized Anxiety Disorder-7 (GAD-7) (42) is a 7-item self-administered scale assessing the frequency with which an individual has been bothered by anxiety symptoms, with each item on a Likert scale from 0 (not at all) to 3 (nearly every day). The total score of all items ranges from 0 to 21 and a higher score indicates higher level of anxiety. A cut point of 10 on the GAD-7 has been recommended for screening generalized anxiety disorders with a sensitivity of 89% and a specificity of 82% in a large-sample research (42). The Chinese version of this scale has been widely applied in clinical institutions and scientific researches (43). Thus, a GAD-7 score of 10 or higher was defined as having elevated anxiety symptoms (probable anxiety) in this study and the Cronbach's α for internal consistency was 0.936.

Perceived stress

Perceived stress was assessed by the Perceived Stress Scale-10 (PSS-10) (44), a self-report instrument measuring the level of perceived stress over the past month. It consists of 10 items on a 5-point Likert scale from 0 (never) to 4 (very often), with a total score of 0–40 and a higher score reflecting higher perception of stress. The PSS-10 has shown superior psychometric properties across a range of populations (45) and Chinese version of the scale has also obtained satisfactory psychometric properties (46). The Cronbach's α for internal consistency in the current sample was 0.799.

Self-efficacy

The self-efficacy was measured by the General Self-Efficacy Scale (GSES) (47), a self-report scale developed by Schwarzer and Jerusalem, which is composed of 10 items for assessing one's generalized sense of self-efficacy regarding resourcefulness and processing power. A 4-point Likert scale is used for each item, from "1" (not at all true) to "4" (exactly true), with a total score ranging from 0 to 40 and a higher score reflecting higher level of self-efficacy. The Chinese version of the scale has demonstrated good reliability and validity (48). The Cronbach's α for internal consistency in the current sample was 0.922.

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1   https://www.wjx.cn

Perceived social support

The Chinese version of the Perceived Social Support Scale (PSSS) was translated and revised by Jiang Qianjin (49) based on the Multidimensional Scale of Perceived Social Support (MSPSS) developed by Zimet et al. (50), which evaluates an individual's perception of support from family, friends and significant others from a subjective perspective. The scale consists of 12 items, each of which rated on a Likert scale from 1 (very strongly disagree) to 7 (very strongly agree), with an aggregate score ranging from 12 to 84 and higher scores indicating higher levels of perceived social support. Multiple samples have demonstrated the scale's reliability and validity to be high (50, 51). The Cronbach's α for internal consistency in the current sample was 0.933.

Statistical analysis

Continuous variables were presented as mean and standard deviation (SD), and categorical variables were presented as frequency and percentage. Normality tests were performed before further analysis. Then, independent t-tests, one-way analysis of variance (ANOVA), or Mann–Whitney U tests were employed to compare the differences between subgroups on depression and anxiety levels (by the scores of PHQ-9 and GAD-7), as appropriate. To examine the association between psychological variables, the Pearson correlation coefficient for continuous variables was calculated. Multiple linear regression analysis (enter) was conducted to identify associated factors for depression and anxiety, with the scores of PHQ-9 and GAD-7 entered as the dependent variables and potential associated variables entered as independent variables. All statistical analyses were performed by SPSS 22.0 (IBM, Chicago, United States), and all tests were two-tailed with the significance level set at $p < 0.05$. In addition, given the small sample size of our study, bias-corrected (BC) bootstrap with 95% confidence interval (CI) based on 5,000 bootstrap samples using the Model 6 in PROCESS macro for SPSS was employed to examine the mediating effects (52). If a 95% BC bootstrap CI does not cover zero, the mediating effect is supported; otherwise, then it is not supported (53).

Results

The process of participant recruitment is illustrated by Figure 1. Initially, 188 respondents completed the questionnaire survey. In conjunction with preliminary questionnaire collation, 8 were excluded due to missing information exceeding 10%, 7 were excluded due to serious physical condition and 6 were excluded due to a previous diagnosis of mental illness. Finally, a total of 167 participants were enrolled in the analysis, with a valid response rate of 89.4%.

Sample characteristics and the prevalence of depression and anxiety

Table 1 presents the demographic characteristics and the prevalence of probable depression and anxiety of the enrolled participants. The final sample was made up of 63 (37.7%) males and 104 (62.3%) females with an average age of 34.41 (SD, 11.9) years and the majority (79.6%) between the ages of 18 and 44. Among the participants, most (71.9%, 120 of 167) held a university or college education or higher, nearly a half (52.1%, 87 of 167) were married, 79.6% (133 of 167) were employed, and the vast majority (84.4%, 141 of 167) were nonsmokers. By the time the study was conducted, the mean duration of segregation for all participants was 21.35 (SD, 15.35) days, with more than a half (59.3%, 99 of 167) exceeding 14 days. During the segregation period, 44.3% (74 of 167) were accompanied by family or pets. Additionally, of the 167 participants, 73 (43.7%) were patients and 94 (56.3%) were healthcare workers. Totally, there were 76 (45.5%) participants being infected with COVID-19, among whom 3 were healthcare workers. With a cut point of 10, the prevalence of probable depression and anxiety determined to be 12.0 and 10.8%, respectively.

Influence of demographic characteristics on depression and anxiety level

The differences in depression and anxiety levels between the subgroups stratified by demographic characteristics were tested (Supplementary Table S1). It was found that healthcare workers ($p = 0.030$), those who were infected ($p = 0.033$) and had been segregated for more than 14 days ($p = 0.002$) reported higher level of anxiety. However, there was no significant difference on depression level between the above subgroups. Moreover, no difference was observed on depression or anxiety levels between participants of different age distribution, gender, education level, marital status, employment status, smoking status, presence of family or pets and COVID-19 infection status.

Correlations between depression, anxiety, perceived stress, self-efficacy, and perceived social support

The levels of depression, anxiety, perceived stress, self-efficacy and perceived social support were measured by PHQ-9, GAD-7, PSS-10, GSES, and PSSS, respectively. Table 2 displays the results of the bivariate correlation analysis of depression, anxiety, perceived stress, self-efficacy and perceived social support, along with their corresponding scale scores. There was a significantly positive correlation between the level of depression and anxiety ($r = 0.790$, $p < 0.01$), and perceived stress ($r = 0.702$, $p < 0.01$), as well as a significantly negative correlation between the level of depression and self-efficacy ($r = -0.350$, $p < 0.01$), and perceived social support ($r = -0.269$, $p < 0.01$). Similarly, there was a significantly positive correlation between the level of anxiety and perceived stress ($r = 0.663$, $p < 0.01$), and a significantly negative correlation between the level of anxiety and self-efficacy ($r = -0.257$, $p < 0.01$), and perceived social support ($r = -0.207$, $p < 0.01$). Furthermore, the level of perceived stress was negatively correlated with self-efficacy ($r = -0.536$, $p < 0.01$) and perceived social support ($r = -0.365$, $p < 0.01$). The level of self-efficacy was positively correlated with perceived social support ($r = 0.344$, $p < 0.01$).

FIGURE 1
Flow chart of the enrollment of study participants.
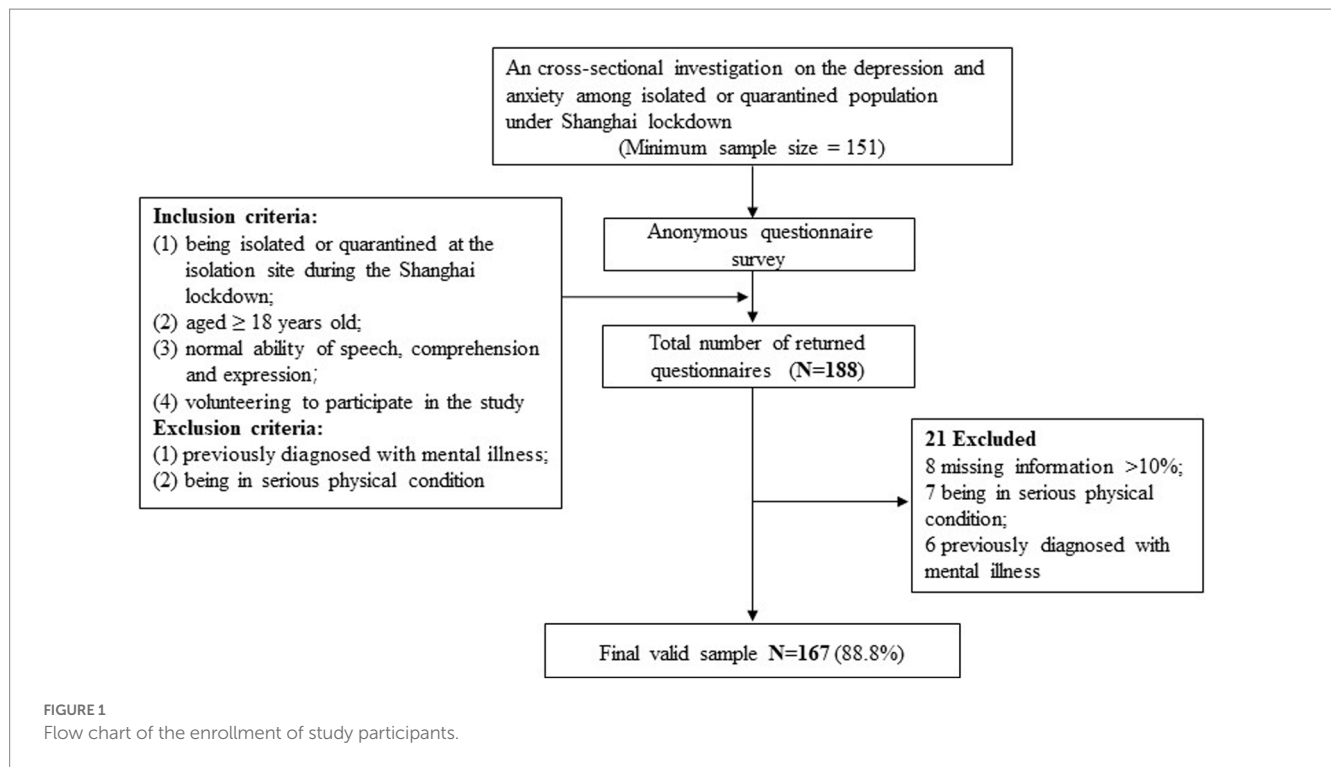
Associated factors for depression and anxiety

Table 3 shows the results of the multiple linear regression models examining the associated factors for depression and anxiety level. It revealed that education level, being healthcare workers, infection status, and the level of perceived stress were significant factors for depression level. Participants with education level of university or college ($B = 1.500$, 95% CI [0.080, 2.919], $p = 0.039$) and postgraduate or above ($B = 2.260$, 95% CI [0.265, 4.256], $p = 0.027$), those being healthcare workers ($B = 3.017$, 95% CI [0.670, 5.364], $p = 0.012$), being infected with COVID-19 ($B = 4.028$, 95% CI [1.598, 6.458], $p = 0.001$) and possessing higher level of perceived stress (B = 0.547, 95% CI [0.448, 0.645], $p < 0.001$) tended to report higher level of depression. Broadly speaking, these variables contributed significantly to the amount of variance in depression level ($R^2 = 56.8\%$, Adjusted $R^2 = 52.8\%$, $F = 14.290$, $p < 0.001$). As for anxiety, the results indicated that higher level of anxiety was significantly associated with education level of university or college ($B = 1.336$, 95% CI [0.012, 2.659], $p = 0.048$) and postgraduate or above ($B = 3.458$, 95% CI [1.598, 5.317], $p < 0.001$), being healthcare workers ($B = 2.275$, 95% CI [0.087, 4.462], $p = 0.042$), being infected with COVID-19 ($B = 3.561$, 95% CI [1.295, 5.826], $p = 0.002$), longer duration of segregation ($B = 0.056$, 95% CI [0.012, 0.100], $p = 0.012$) and higher level of perceived stress ($B = 0.540$, 95% CI [0.448, 0.633], $p < 0.001$). Likewise, the amount of variance in anxiety level accounted for by these variables was statistically significant ($R^2 = 57.9\%$, Adjusted $R^2 = 54.0\%$, $F = 14.906$, $p < 0.001$).

Mediating effects testing

Taking into account the existence of significant correlations between depression, anxiety, perceived stress, self-efficacy and perceived social support, the nonparametric BC bootstrapping over 5,000 samples with 95% CI was employed to further test the chain mediating effect of self-efficacy and perceived stress on the association between perceived social support and depression (anxiety). The above demographic variables were treated as covariates in the mediation models. As indicated by Table 4; Figure 2, perceived stress played an intermediary role between perceived social support and depression (BC 95% CI [−0.1063, −0.0096]) with an effect size of −0.0547. While the mediating effect of self-efficacy between perceived social support and depression were not significant (BC 95% CI [−0.0111, 0.0224]), the chain mediating effect of self-efficacy and perceived stress between perceived social support and depression was estimated lie between −0.0717 and −0.0163 with 95% confidence, which did not contain zero. It could be concluded that the chain mediating effect of self-efficacy and perceived stress between perceived social support and depression was significant with an estimated effect size of −0.0422. Combined with the total and direct effects, the results could be interpreted that individuals possessing higher level of perceived social support had higher self-efficacy and lower perceived stress, which in turn led to lower level of depression. Likewise, the mediating effect of perceived stress between perceived social support and anxiety was significant (BC 95% CI [−0.1034, −0.0091]) with an effect size of −0.0531. The chain mediating effect of self-efficacy and perceived stress between perceived social support and anxiety was significant (BC 95% CI [−0.0697, −0.0161]) with an effect size of −0.0409. Besides, the direct effect of perceived social support on depression and anxiety was not significant (BC 95% CI [−0.0545, 0.0341] and [−0.0519, 0.0307], respectively), indicating that self-efficacy and perceived stress completely mediated the relationship between perceived social support and depression (anxiety), and the proportion of indirect effect in total effect was 100%. Generally, the

TABLE 1 Demographic characteristics and mood disorders of the participants (*N*=167).

Variables	*n*	%
Age (M, SD)	34.41	11.90
18–44	133	79.6
45–59	25	15.0
60–74	9	5.4
Gender		
Male	63	37.7
Female	104	62.3
Education level		
High school or below	47	28.1
University or college	74	44.3
Postgraduate or above	46	27.5
Marital status		
Unmarried	80	47.9
Married	87	52.1
Employment status		
Employed	133	79.6
Unemployed	34	20.4
Smoking status		
Nonsmoker	141	84.4
Smoker	26	15.6
Presence of family or pets		
Yes	74	44.3
No	93	55.7
Current status		
Patients	73	43.7
Healthcare workers	94	56.3
Infected or not		
No	91	54.5
Yes	76	45.5
Duration of segregation (days, M, SD)	21.52	15.35
≤ 14	68	40.7
> 14	99	59.3
Depression (M, SD)	5.16	4.69
PHQ-9 ≥ 10	20	12.0
PHQ-9 < 10	147	88.0
Anxiety	4.14	4.43
GAD-7 ≥ 10	18	10.8
GAD-7 < 10	149	89.2

M, Mean. SD, Standard deviation. PHQ-9, Patient Health Questionnaire-9. GAD-7, Generalized Anxiety Disorder-7.

TABLE 2 Correlations between depression, anxiety, perceived stress, self-efficacy and perceived social support.

	1	2	3	4	5
1. Depression	1				
2. Anxiety	0.790**	1			
3. Perceived stress	0.702**	0.663**	1		
4. Self-efficacy	−0.350**	−0.257**	−0.536**	1	
5. Perceived social support	−0.269**	−0.207**	−0.365**	0.344**	1
Mean	5.16	4.14	13.37	25.94	61.04
Standard deviation	4.69	4.43	6.29	6.34	13.18

**$p < 0.01$.

Discussion

The present study was the first to address the chain mediating effect of self-efficacy and perceived stress on the association between perceived social support and depression (anxiety) among populations isolated or quarantined in Shanghai lockdown induced by the COVID-19 pandemic. The results revealed that 12 and 10.8% people under isolation or quarantine reported elevated level of depression and anxiety symptoms, respectively. Higher levels of depression and anxiety were related to higher education level, being healthcare workers (compared with COVID-19 patients), being infected with COVID-19 and higher perceived stress level. Longer duration of isolation or quarantine was also identified as a risk factor for anxiety. In addition, self-efficacy and perceived stress significantly mediated the association between perceived social support and depression (anxiety).

The prevalence of probable depression and anxiety was estimated to be 12 and 10.8% in this study, which was relatively lower than findings reported by previous studies, among which the prevalence of depression or anxiety during the COVID-19 pandemic ranged from 20 to 45% across diverse populations and geographic areas (13, 20, 24, 54, 55). Additionally, a recent cross-sectional study on population mental health under Shanghai lockdown reported a higher prevalence of depression (25.9%) and anxiety (19.9%) (56). China's experience in containment, treatment and vaccines in response to the COVID-19 challenge and nationwide efforts to fight against the pandemic might buffer the psychological stress induced by the lockdown. Furthermore, it was reflected that the communication between infected patients and healthcare workers at the centralized site was excellent and they were encouraged to take moderate exercise (such as Tai Chi) during that period, which might create positive effects on their mental and physical health. Nevertheless, it is worth noting that the current prevalence is still higher than the lifetime prevalence of depressive disorders in adults Chinese, which was estimated to be 6.8% (57). Several studies noted that isolation and quarantine might arise detrimental psychological and physical effects as a result of restricted physical activity and social interaction, as well as changes in routine practices (58, 59). Accordingly, it makes sense to identify mental distress and implement appropriate psychological interventions in time as soon as public emergencies happen.

The findings revealed that isolated or quarantined populations with higher education level were more apt to develop depression or

above findings confirmed that higher level of perceived social support generated higher self-efficacy and lower perceived stress, which alleviated the level of depression and anxiety among people isolated or quarantined under COVID-19 lockdown.

TABLE 3 Multiple linear regression analysis of associated factors for depression and anxiety level.

	Depression level			Anxiety level		
	B	95% CI	*p* value	*B*	95% CI	*p* value
Age	0.012	[−0.051, 0.074]	0.717	0.039	[−0.020, 0.097]	0.191
Gender						
Male	Reference					
Female	−0.873	[−2.083, 0.337]	0.156	−0.006	[−1.134, 1.122]	0.992
Education level						
High school or below	Reference					
University or college	1.500	[0.080, 2.919]	0.039	1.336	[0.012, 2.659]	0.048
Postgraduate or above	2.260	[0.265, 4.256]	0.027	3.458	[1.598, 5.317]	<0.001
Marital status						
Unmarried	Reference					
Married	−1.131	[−2.655, 0.393]	0.145	−0.413	[−1.834, 1.007]	0.566
Employment status						
Employed	Reference					
Unemployed	−0.438	[−1.742, 0.865]	0.507	−0.145	[−1.360, 1.070]	0.814
Smoking status						
Nonsmoker	Reference					
Smoker	−0.431	[−1.955, 1.092]	0.577	−1.212	[−2.633, 0.208]	0.094
Presence of family or pets						
Yes	Reference					
No	−0.457	[−1.582, 0.669]	0.424	0.060	[−0.989, 1.110]	0.910
Current status						
Patients	Reference					
Healthcare workers	3.017	[0.670, 5.364]	0.012	2.275	[0.087, 4.462]	0.042
Infected or not						
No	Reference					
Yes	4.028	[1.598, 6.458]	0.001	3.561	[1.295, 5.826]	0.002
Duration of segregation	0.039	[−0.008, 0.087]	0.100	0.056	[0.012, 0.100]	0.012
Perceived stress	0.547	[0.448, 0.645]	<0.001	0.540	[0.448, 0.633]	<0.001
Self-efficacy	0.034	[−0.066, 0.134]	0.503	0.082	[−0.011, 0.175]	0.084
Perceived social support	−0.013	[−0.058, 0.032]	0.574	−0.008	[−0.050, 0.034]	0.715
R^2	0.568			0.579		
Adjusted R^2	0.528			0.540		
F	14.290***			14.906***		

***$p < 0.001$.

B, Unstandardized coefficient; CI, Confidence interval.

Education level was transformed into two dummy variables with high school or below as the reference group (university or college vs. high school or below, postgraduate or above vs. high school or below).

anxiety symptoms in comparison with those with a high school education or less, which was in consistent with prior findings that higher education level was significantly related to psychological distress like depression and stress (60, 61). It could be conceived that people possessing higher education are likely to bear more burden on work, family or academic tasks, which contributed to their vulnerability to the impact of COVID-19. Conversely, it was suggested by other relevant studies that less educated was connected with elevated levels of depression and anxiety resulted from the COVID-19

(62, 63). A former study even found no significant relationship between education level and mental health issues among nurses under the COVID-19 pandemic (37). Moreover, no association was discovered between other demographic characteristics and levels of depression and anxiety in this study, despite the fact that demographic characteristics such as age and gender have been linked to the psychological impacts of COVID-19 in numerous studies (13, 64). Such contradictions highlight the need for additional research in the relevant field.

It was found that longer duration of segregation was related to higher level of anxiety, which tied well with studies wherein quarantine length was associated with depression or anxiety (12, 13). Importantly, Lu et al. observed a dynamic pattern of anxiety and depression levels in quarantined populations, finding that anxiety and depression levels significantly increased at the initial stage of the quarantine, followed by a gradual decline, and went back up again as the quarantine progressed beyond 14 days (65). Long duration of segregation might add to the uncertainty in the pandemic containment and worry about their own health among isolated or quarantined populations. In light of the emotion fluctuations, further study with multiple evaluations on depression and anxiety symptoms is needed.

Results showed that healthcare workers reported more severe depression and anxiety symptoms. It could construe that healthcare

workers were faced with more challenges in diverse aspects of work and life: the responsibilities of treating infected patients to prevent the spread of the virus; developing proper short-term programs and long-term plans; the discomfort caused by medical protective equipment; the fear of being infected or family member infected; balancing work and family and so on (66, 67). Numerous studies have now found that healthcare workers suffer from varying extent of psychological distress during public health emergencies like COVID-19 pandemic and Severe acute respiratory syndrome (SARS) (68–70). Thus, appropriate and practical psychological interventions should be provided to healthcare workers engaged in the management of COVID-19 patients.

Not surprisingly, individuals infected with COVID-19 exhibited higher levels of depression and anxiety, which was generally in accordance with previous studies. A substantial body of studies have reported acute and long-term health consequences in COVID-19 patients, including depression and anxiety disorders (71–73). Additionally, it has been well documented that major infectious diseases, such as SARS and Middle East respiratory syndrome (MERS) may affect the health of infected patients both physically and psychologically, even after the acute infection has subsided (74–78). As a result, psychological rehabilitation of COVID-19 patients is worth for equal concern.

In our study, the results showed that perceived social support and self-efficacy were negatively correlated to depression and anxiety level, while perceived stress was positively correlated to depression and anxiety level in isolated or quarantined people under lockdown. Moreover, self-efficacy and perceived stress played a completely intermediary role between perceived social support and depression (anxiety). That is to say, individuals who perceived low levels of social support tended to be accompanied by low self-efficacy and high perceived stress, which gave rise to subsequent development of depression and anxiety. Here, perceived social support and self-efficacy could be recognized as protective factors for depression and anxiety symptoms, while high perceived stress was a risk factor. The level of perceived stress under the COVID-19 pandemic merited special attention. A study examining the stress and psychological impact in SARS patients at the peak of the outbreak found that stress level not only increased but also correlated with negative psychological effects (79). Previous study also demonstrated that perceived stress level significantly mediated the relationship between negative life events and depression (80, 81). As important parts of personal cognitive resources, it is widely believed that perceived social support and self-efficacy could buffer the detrimental

TABLE 4 Examination of chain mediating effects.

Model pathways	Effect	Boot SE	Boot LLCI	Boot ULCI
Perceived social support (X) → self-efficacy (M1) → perceived stress (M2) → depression (Y)				
Direct effect	−0.0102	0.0224	−0.0545	0.0341
Indirect effect (total)	−0.0915	0.0262	−0.1431	−0.0414
X → M1 → Y	0.0055	0.0083	−0.0111	0.0224
X → M2 → Y	−0.0547	0.0245	−0.1063	−0.0096
X → M1 → M2 → Y	−0.0422	0.0140	−0.0717	−0.0163
Total effect	−0.1016	0.0293	−0.1596	−0.0437
Perceived social support (X) → self-efficacy (M1) → perceived stress (M2) → anxiety (Y)				
Direct effect	−0.0106	0.0209	−0.0519	0.0307
Indirect effect (total)	−0.0817	0.0247	−0.1317	−0.0343
X→M1→Y	0.0123	0.0082	−0.0023	0.0302
X→M2→Y	−0.0531	0.0238	−0.1034	−0.0091
X→M1→M2→Y	−0.0409	0.0134	−0.0697	−0.0161
Total effect	−0.0923	0.0274	−0.1465	−0.0382

Boot SE, Standard error under bias-corrected percentile bootstrap method. Boot LLCI = 95% confidence interval lower; Boot ULCL = 95% confidence interval upper. Demographic variables were treated as covariates in the mediation models. Number of bootstrap samples for percentile bootstrap confidence intervals is 5000.

FIGURE 2
The chain mediation model with standardized path coefficients. **, *p* < 0.01; ***, *p* < 0.001; c, total effect; c', direct effect. **(A)** The chain mediating effect of self-efficacy and perceived stress between perceived social support and depression; **(B)** The chain mediating effect of self-efficacy and perceived stress between perceived social support and anxiety.
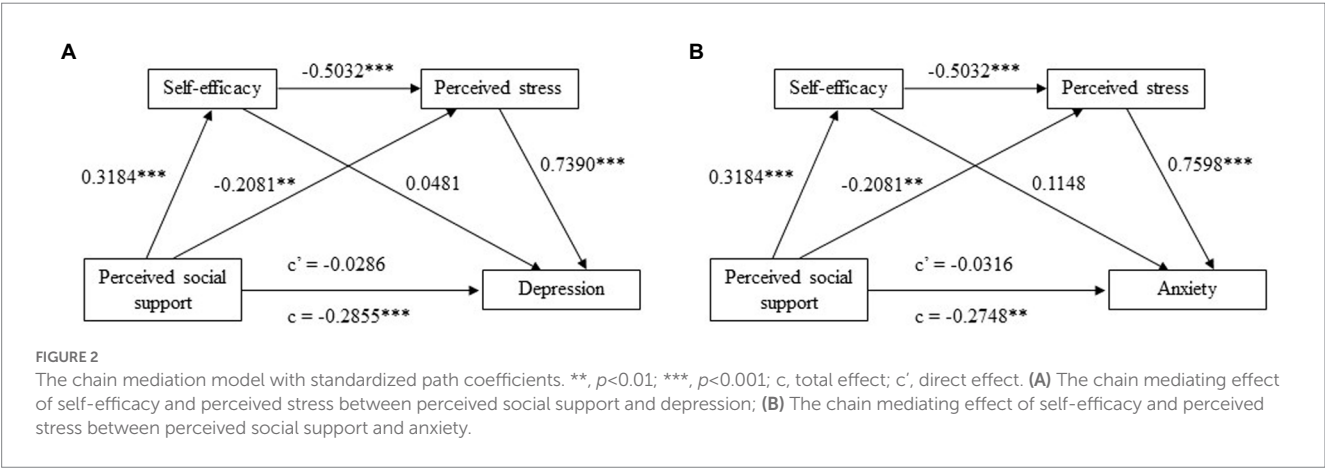
effects of stress on psychological conditions (82–85). Ma et al. conducted a nation-wide survey on the mental health of college students during the COVID-19 pandemic in China, illustrating that students with low perceived social support were more likely to have anxiety and depressive symptoms (86). A recently published study showed a significant correlation between self-efficacy and depression, anxiety and stress in the context of COVID-19 (87). From this standpoint, it is meaningful and constructive to promote one's perceived social support and self-efficacy when developing suggestions or interventions for alleviating depressive and anxiety symptoms in isolated or quarantined populations.

Limitations

Findings from this study presented potentially significant contributions to understanding the role of perceived stress, self-efficacy and perceived social support in the development of negative psychological consequences under COVID-19 lockdown. In spite of this, the findings of this study should be viewed in light of several limitations. The major limitation was the administration of self-report measures for depression and anxiety symptoms. Notably, a more persuasive standard for making psychiatric diagnoses must contain a structured clinical interview. Another limitation involved the nature of a cross-sectional study, which lacked baseline data on levels of depression, anxiety and perceived stress prior to the implementation of lockdown measures. Finally, the actual prevalence in this study was relatively lower than the estimated prevalence used in sample size calculation, which might limit the accuracy of the results. Future research should be conducted with more high-quality designs and comprehensive assessments in order to identify psychological disorders in populations affected by COVID-19 pandemic.

Conclusion

The present findings confirmed high-risk populations and associated factors for higher level of depression and anxiety among populations under isolation or quarantine, including risk factors (high education level, being infected, longer duration of segregation and high level of perceived stress) and protective factors (self-efficacy and perceived social support). To sum up, managing elevated mental health burden under the COVID-19 pandemic cannot be overlooked, and authorities must strengthen their mental health service response. Recommended psychological strategies should take on board suggestions to promote personal mental resources and target interventions to support individuals who are disturbed by various mental distresses.

Data availability statement

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

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Ethics statement

Author contributions

LS, XW, YH, YL, and YW designed the study and wrote the protocols. YH, CL, WZ, PL, YX, and YC participated in the data collection and organization. LS and XW undertook the statistical analysis and wrote the manuscript, and then all authors participated in the revision. All authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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Conflict of interest

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

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Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyt.2023.1100242/full#supplementary-material

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Anxiety among hospitalized COVID-19 patients: a case–control study from a tertiary teaching hospital in Malaysia

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Introduction: Anxiety has been increasingly recognized as part of the psychosocial health issues in COVID-19 patients. However, the impact of this topic may be underestimated in low- and middle-income countries. This study aimed to estimate the prevalence of and risk factors of anxiety in COVID-19 patients compared to controls in a local tertiary teaching hospital in Malaysia.

Methods: In this case–control study, we analyzed data on adult patients aged 18 years and above hospitalized for COVID-19 infection with matched hospitalized controls. The demographic, clinical data and anxiety measures using the Generalized Anxiety Disorder-7 questionnaire were analyzed using univariate and multivariate analysis.

Results: 86.6% in the COVID-19 group had anxiety, significantly higher than 13.4% in the control group ($p=0.001$). The COVID-19 group was significantly associated with the GAD-7 severity ($p=0.001$). The number of COVID-19 patients in the mild, moderate, and severe anxiety groups was 48 (84.2%), 37 (86%), and 18 (94.7%), respectively. Multiple logistic regression showed significant predictors for anxiety, including COVID-19 diagnosis and neurological symptoms. Anxiety was found 36.92 times higher in the patients with COVID-19 compared to those without COVID-19 (OR 36.92; 95% CI 17.09, 79.78, $p=0.001$). Patients with neurological symptoms were at risk of having anxiety (OR 2.94; 95% CI 1.03, 8.41, $p=0.044$).

Discussion: COVID-19 patients experience a significant disruption in psychosocial functioning due to hospitalization. The burden of anxiety is notably high, compounded by a diagnosis of COVID-19 itself and neurological symptomatology. Early psychiatric referrals are warranted for patients at risk of developing anxiety symptoms.

1. Introduction

There has been a growing recognition of neuropsychiatric manifestations since the declaration of the COVID-19 pandemic. The two most prevalent disabling mental disorders were depressive and anxiety disorders. A meta-analysis of mental health burden following the impact of COVID-19 showed that the prevalence of anxiety was 27.77% (CI: 24.47–31.32) (1). Previous studies have reported prevalence rates of anxiety between 18.6% (2) –34.72% (3). Hospitalized COVID-19 patients invariably have high anxiety levels from multifactorial etiology. This has been reflected following high anxiety levels in hospitalized COVID-19 patients in Turkey (4) and Iran (5). Anxiety is associated with specific stressors in hospitalized patients, which the additional burden of COVID-19 may further compound. Factors such as uncertainty, the inadequacy of explanation, isolation from family, physical effects of the illness, and financial worries may cause formidable barriers in this vulnerable group.

The South East Asia region had recorded 57 million confirmed cases and more than half a million deaths from COVID-19 infections (6). Malaysia had reported approximately 30,000 deaths by December 2021 (7). The impact of COVID-19 has not only resulted in a financial burden but also caused a sharp rise in psychological disorders in the population. Previous studies in Malaysia have focused on specific groups: healthcare workers (8, 9), children with autism (10), women (11), general population (12), urban and rural communities (13) and university students (14). There is a paucity of literature that compared anxiety levels between COVID-19 patients and other hospitalized medical patients, especially from this region.

Determining variables associated with anxiety in COVID-19 patients may be impeded by several issues, such as coexisting medical illnesses, clinical features, the severity and complications of the disease, and the duration of hospitalization or quarantine period. However, it is crucial to determine factors associated with developing anxiety so that we can address them earlier. This knowledge gap remains problematic as it is more challenging to perform studies in hospitalized COVID-19 patients who may also suffer from complications of the disease and its psychological effects. To address this gap, we embark on this study to determine the prevalence and risk factors of anxiety in COVID-19 patients compared to non-COVID-19 patients as controls in a tertiary teaching hospital in Malaysia.

2. Materials and methods

2.1. Study design and study population

This case–control study was conducted between 1 June 2021 and 31 December 2022 at Hospital Canselor Tuanku Muhriz, National University of Malaysia. This tertiary teaching hospital has received COVID-19 cases since the pandemic began in 2020.

The study population was recruited *via* simple random sampling and patients had to fulfill the following criteria: (1) Patients more than 18 years old with a diagnosis of COVID-19 *via* qualitative reverse

transcription polymerase chain reaction (RT-PCR) from nasopharyngeal and/or oropharyngeal swab, and (2) Hospitalized patients. The controls were matched to the cases by gender and age. They were hospitalized patients in the medical wards due to other medical conditions apart from COVID-19 infection.

2.2. Data collection

Upon admission, consent was taken from the patients or the next of kin/caregivers. The patients/caregivers were given a set of questions to be answered on a virtual questionnaire according to their suited language (English and Bahasa Malaysia). The clinical and laboratory investigation data were further collated.

2.3. Ethical statement

This study was conducted following the guidelines in the Declaration of Helsinki and was approved by the Ethics and Research Board of the Faculty of Medicine, the National University of Malaysia FF-2021-379.

2.4. Questionnaire sections

2.4.1. Demographic variables

This section explored demographic and occupational characteristics. The demographic variables included age, gender, marital status, occupation, habits (smoking and alcohol), and education level.

2.4.2. Clinical variables

The second section explored the clinical characteristics of comorbidities, presenting symptoms, and laboratory parameters. The presenting symptoms were divided into respiratory symptoms (fever, runny nose, sore throat, shortness of breath, and cough), gastrointestinal symptoms (diarrhea, vomiting, abdominal pain, and poor oral intake), neurological symptoms (seizures, limb weakness, headache, and dizziness), and musculoskeletal symptoms (muscle and joint pains). The severity of patients with COVID-19 was divided to five clinical categories according to our local guidelines (15): 1—asymptomatic, 2—symptomatic, 3—evidence of pneumonia, 4—oxygen supplement requirement, and 5—intubated and/or multiorgan failure. In addition, the laboratory data were retrieved from the hospital's data management system.

2.4.3. Anxiety variable

The third section consists of the study instrument which was a questionnaire on General Anxiety Disorder-7 (GAD-7) in English (16) and the validated Bahasa Malaysia version (17). The patients had the alternative to answer in English or the Bahasa Malaysia version. The GAD-7 questionnaire is a 7-item, self-reporting anxiety questionnaire designed to evaluate mental health symptoms. The questionnaire inquires about the degree to which the patient has been bothered by feeling nervous, anxious, on edge; not being able to stop or control worrying; worrying too much about different things; having trouble relaxing; being so restless that it is hard to sit still; becoming

easily annoyed or irritable; and feeling afraid as if something awful might happen. This scale consists of 7 questions responded on a four-point Likert scale ranging from 0 (not at all), 1 (several days), 2 (more than half the days) to 3 (nearly every day). GAD-7 total score for the seven items ranged from 0 to 21. A total score of 0–4 indicates minimal anxiety, 5–9 indicates mild anxiety, 10–14 indicates moderate anxiety, and 15–21 indicates severe anxiety. The GAD-7 is a valid and efficient tool for screening for GAD and assessing its severity in clinical practice and research with 89% sensitivity and 82% specificity. Previous studies that employed similar tools showed a prevalence rate of 17.9–22.6% for GAD during the COVID-19 outbreak (18, 19).

2.5. Statistical analysis

Data were analyzed using the software SPSS Statistic for Windows, version 25. Data normality was evaluated using one-sample Kolmogorov–Smirnov presented as median ± interquartile range for skewed data and frequency (percentage) for nominal data. The demographic factors and clinical characteristics (categorical variables) were analyzed using the Chi-square test. The variables were divided into demographic, clinical (clinical characteristics and laboratory investigations), and anxiety variables. The multivariate logistic regression analysis was performed by including the variables with a value of p less than 0.05 from the simple logistic regression analysis.

3. Results

3.1. Demographic variables

The distribution of the demographic characteristics is shown in Table 1. Of the 223 patients, 118 were COVID-19 positive, and 105 were in the control group. Overall, the median (IQR) age of the COVID-19 and control groups was 54 (40.75, 65) years and 56 (37.50, 68) years, respectively ($p = 0.975$; Table 2). There was no significant difference in patients' age, gender, marital status, race, habits, and education level. Only the employment status was significantly different between both groups, where the number of those who were employed in the COVID-19 group was higher (57, 67.1%) compared to the control group (28, 32.9%; $p = 0.001$). The median (IQR) length of hospitalization was significantly higher in the COVID-19 group, 12 (8.00, 20.25) compared to the control group, 10 (5.00, 17.50; $p = 0.032$; Table 2).

3.2. Clinical variable

In terms of the clinical parameters, there were more patients in the COVID-19 group with respiratory symptoms ($p = 0.001$), gastrointestinal symptoms ($p = 0.02$), neurological symptoms ($p = 0.008$), and musculoskeletal symptoms (muscle and joint pain; $p = 0.001$) compared to controls.

3.3. Anxiety variable

The median (IQR) GAD score was significantly higher in the COVID-19 group, 8 (7,14) compared to the control group, 1 (0,2;

$p = 0.001$). The proportion of the COVID-19 group who had anxiety was significantly higher (103, 86.6%) compared to the control group (16,13.4%; $p = 0.001$). The COVID-19 group had a significant association with the GAD-7 severity ($p = 0.001$). The number of COVID-19 patients in the mild, moderate, and severe anxiety groups was 48 (84.2%), 37 (86%), and 18 (94.7%), respectively. In comparison, the proportion of the control group who were in the mild, moderate, and severe categories were 9 (15.8%), 6 (14%), and 1 (5.3%), respectively.

In the laboratory parameters, the COVID-19 group had a significant association with hemoglobin ($p = 0.04$), white cell count levels ($p = 0.005$), and alanine transaminase level ($p = 0.005$; Table 1).

Table 3 shows the association between the variables and anxiety. Among the demographic factors, only employment ($p = 0.001$) and COVID-19 ($p = 0.001$) diagnoses had a significant association with anxiety. Those employed in the COVID-19 group were higher (57, 67.1%) compared to the control group (15, 12.7%). The proportion of COVID-19 patients with anxiety was higher (103, 87.3%) than the control group (15, 12.7%).

The proportion of COVID-19 patients with anxiety was higher (103, 87.3%) compared to the control group (15, 12.7%; $p = 0.001$). Among the COVID-19 categories, category 3 had the highest proportion of patients (24, 92.3%) with anxiety ($p = 0.001$). The clinical symptoms that had a significant association with anxiety were respiratory symptoms ($p = 0.001$), neurological symptoms ($p = 0.001$), and musculoskeletal symptoms ($p = 0.003$). Among the investigations, only sodium level was associated with anxiety, where the number of COVID-19 patients with low sodium levels was 65(60.2%) compared to 43 (47.6%) in the control group ($p = 0.048$).

3.4. Risk factors for anxiety

Results of the univariate and multiple logistic regression analysis are shown in Table 4. In the univariate analysis, several factors showed significance for anxiety. These factors include the presence of diagnosis, employment, diabetes mellitus, respiratory symptoms, neurological symptoms, gastrointestinal symptoms, and musculoskeletal symptoms ($p < 0.05$). Further analysis by multiple logistic regression showed significant predictors for anxiety, including COVID-19 diagnosis and neurological symptoms. The diagnosis of COVID-19 was more likely to have anxiety compared to non-COVID-19 diseases (OR 36.92; 95% CI 17.09, 79.78, $p = 0.001$). We also found that patients with neurological symptoms were 2.94 times likely to have anxiety (OR 2.94; 95% CI 1.03, 8.41, $p = 0.044$; Table 4).

4. Discussion

4.1. Prevalence of anxiety

The impact of the COVID-19 pandemic has caused a resultant increase in the psychological burden, including anxiety disorders. Mental health issues have emerged in general society but have also affected hospitalized patients (20, 21). The reported prevalence of anxiety in hospitalized COVID-19 patients ranged from 34.72% (2) to 60.35% (20, 21). A study performed in an urban hospital in Bangladesh

TABLE 1 Demographic, clinical characteristics, GAD-7 score, and laboratory investigations of the study population and controls.

		Total	Control n (%)	COVID-19 n (%)	χ^2	p
Demographic variables						
Age group (years)	15–64	157	73 (46.5)	84 (53.5)	0.07	0.786
	>65	66	32 (48.5)	34 (51.5)		
Gender	Male	141	68 (48.2)	73 (51.8)	0.20	0.654
	Female/	82	37 (45.1)	45 (54.9)		
Marital status	Single	41	21 (51.2)	20 (48.8)	0.35	0.557
	Married	182	84 (46.2)	98 (53.8)		
Ethnic group	Malay	138	66 (47.8)	72 (52.2)	0.41	0.937
	Chinese	52	24 (46.2)	28 (53.8)		
	Indian	18	9 (50)	9 (50)		
	Others	15	6 (40)	9 (60)		
Habits	None	182	82 (45.1)	100 (54.9)	5.90	0.117
	Smoking	34	21 (61.8)	13 (38.2)		
	Alcohol	2	0 (0)	2 (100)		
	Smoking and Alcohol	5	2 (40)	3 (60)		
Education level	None	6	3 (50)	3 (50)	1.01	0.799
	Primary	58	29 (50)	29 (50)		
	Secondary	133	63 (47.4)	70 (52.6)		
	University	26	10 (38.5)	16 (61.5)		
Employment	Unemployed	138	77 (55.8)	61 (44.2)	11.03	0.001*
	Employed	85	28 (32.9)	57 (67.1)		
Clinical characteristics						
Respiratory symptoms (fever, runny nose, sore throat, shortness of breath, and cough)	No	57	44 (77.2)	13 (22.8)	26.26	0.001*
	Yes	166	61 (36.7)	105 (63.3)		
Fever	No	99	61 (61.6)	38 (38.4)	14.06	0.001*
	Yes	124	44 (35.5)	80 (64.5)		
Runny nose	No	205	105 (51.2)	100 (48.8)	15.43	0.001*
	Yes	18	0 (0)	18 (100)		
Sore throat	No	193	105 (54.4)	88 (45.6)	28.70	0.001*
	Yes	30	0 (0)	30 (100)		
Shortness of breath	No	155	89 (57.4)	66 (42.6)	21.79	0.001*
	Yes	68	16 (23.5)	52 (76.5)		
Cough	No	134	91 (67.9)	43 (32.1)	58.44	0.001*
	Yes	89	14 (15.7)	75 (84.3)		
Gastrointestinal symptoms (diarrhea, vomiting, abdominal pain, and poor intake)	No	207	93 (44.9)	114 (55.1)	5.39	0.020*
	Yes	16	12 (75)	4 (25)		
Diarrhea	No	218	103 (47.2)	115 (52.8)	0.00	1.000
	Yes	5	2 (40)	3 (60)		
Vomiting	No	220	102 (46.4)	118 (53.6)	1.60	0.205
	Yes	3	3 (100)	0 (0)		
Abdominal pain	No	216	99 (45.8)	117 (54.2)	2.88	0.090
	Yes	7	6 (85.7)	1 (14.3)		

(Continued)

TABLE 1 (Continued)

		Total	Control n (%)	COVID-19 n (%)	χ^2	p
Poor intake	No	219	102 (46.6)	117 (53.4)	0.39	0.533
	Yes	4	3 (75)	1 (25)		
Neurological symptoms (seizures, weakness, headache, and dizziness)	No	181	93 (51.4)	88 (48.6)	7.12	0.008*
	Yes	42	12 (28.6)	30 (71.4)		
Seizures	No	220	103 (46.8)	117 (53.2)	0.01	0.919
	Yes	3	2 (66.7)	1 (33.3)		
Weakness	No	217	100 (46.1)	117 (53.9)	1.93	0.165
	Yes	6	5 (83.3)	1 (16.7)		
Headache	No	197	103 (52.3)	94 (47.7)	16.58	0.001*
	Yes	26	2 (7.7)	24 (92.3)		
Dizziness	No	212	102 (48.1)	110 (51.9)	1.08	0.298
	Yes	11	3 (27.3)	8 (72.7)		
Muscle and joint pain	No	206	104 (50.5)	102 (49.5)	10.81	0.001*
	Yes	17	1 (5.9)	16 (94.1)		
Comorbidities						
Diabetes mellitus	No	139	58 (41.7)	81 (58.3)	4.25	0.039*
	Yes	84	47 (56)	37 (44)		
Hypertension	No	125	56 (44.8)	69 (55.2)	0.60	0.440
	Yes	98	49 (50)	49 (50)		
Chronic kidney disease	No	193	87 (45.1)	106 (54.9)	2.32	0.128
	Yes	30	18 (60)	12 (40)		
Dyslipidemia	No	189	91 (48.1)	98 (51.9)	0.56	0.453
	Yes	34	14 (41.2)	20 (58.8)		
Ischemic heart disease	No	191	89 (46.6)	102 (53.4)	0.13	0.721
	Yes	32	16 (50)	16 (50)		
Bronchial asthma	No	208	102 (49)	106 (51)	3.64	0.056
	Yes	15	3 (20)	12 (80)		
Anxiety variable						
GAD-7 score	minimal anxiety	104	89 (85.6)	15 (14.4)	115.90	0.001*
	Anxiety	119	16 (13.4)	103 (86.6)		
GAD-7 severity	Minimal anxiety	104	89 (85.6)	15 (14.4)	130.26	0.001*
	Mild anxiety	57	9 (15.8)	48 (84.2)		
	Moderate anxiety	43	6 (14)	37 (86)		
	Severe anxiety	19	1 (5.3)	18 (94.7)		
Laboratory investigations						
Hemoglobin g/dL	12.0–15.0	99	39 (39.4)	60 (60.6)	4.23	0.040*
	Abnormal	124	66 (53.2)	58 (46.8)		
White cell count x10⁹/L	4.0–10.0	124	48 (38.7)	76 (61.3)	7.86	0.005*
	Abnormal	99	57 (57.6)	42 (42.4)		
Platelet x10⁹/L	150–410	167	76 (45.5)	91 (54.5)	0.66	0.415
	Abnormal	56	29 (51.8)	27 (48.2)		

(Continued)

TABLE 1 (Continued)

		Total	Control n (%)	COVID-19 n (%)	χ^2	p
Sodium mmol/L	136–145	115	61 (53)	54 (47)	3.38	0.066
	Abnormal	108	44 (40.7)	64 (59.3)		
Potassium mmol/L	3.5–5.1	176	88 (50)	88 (50)	2.85	0.092
	Abnormal	47	17 (36.2)	30 (63.8)		
Urea mmol/L	2.5–6.7	129	57 (44.2)	72 (55.8)	1.03	0.310
	Abnormal	94	48 (51.1)	46 (48.9)		
Creatinine μmol/L	50.4–98.1	124	53 (42.7)	71 (57.3)	2.12	0.146
	Abnormal	99	52 (52.5)	47 (47.5)		
Total protein g/L	64–83	170	78 (45.9)	92 (54.1)	0.42	0.519
	Abnormal	53	27 (50.9)	26 (49.1)		
Albumin g/L	34–48	106	49 (46.2)	57 (53.8)	0.06	0.807
	Abnormal	117	56 (47.9)	61 (52.1)		
Bilirubin μmol/L	3.4–20.5	183	85 (46.4)	98 (53.6)	0.17	0.683
	Abnormal	40	20 (50)	20 (50)		
Alanine transaminase IU/L	0–55	180	93 (51.7)	87 (48.3)	7.86	0.005*
	Abnormal	43	12 (27.9)	31 (72.1)		
Alkaline phosphatase IU/L	40–150	191	89 (46.6)	102 (53.4)	0.13	0.721
	Abnormal	32	16 (50)	16 (50)		

*Significant $p < 0.05$; χ2, Chi-square test; GAD-7, Generalized Anxiety Disorder-7.

showed that 30.7% of hospitalized patients with anxiety [22]. A systemic review found that patients experience symptoms of anxiety (30–39%), depression (9–26%), and insomnia (24–40%) during and 3 months post-COVID-19 hospitalization [23].

A study from a local hospital in Malaysia regarding the psychological impact of COVID-19 patients found that the proportions of depressed, moderately anxious, and stressed patients were 20.5, 38.9, and 17.3%, respectively [24]. This study was carried out in Ipoh, the capital of the Malaysian state of Perak, which is situated about 180 km north of Kuala Lumpur, the capital of Malaysia. Another local study reported a prevalence rate of 7% among stable hospitalized patients [25]. On the contrary, our data from an urban tertiary teaching hospital in Kuala Lumpur revealed a higher prevalence of anxiety in hospitalized COVID-19 patients at 86.6%. The presence of COVID-19 has a 36 higher odds ratio to developing anxiety. This is in keeping with the predicted increment in anxiety disorders, posttraumatic stress disorders, obsessive–compulsive disorders, and the aversive social effects of isolation in Malaysia [26]. An earlier community survey of anxiety in 2015, before the COVID-19 pandemic, only showed a prevalence of 8.2% in Malaysia [27]. Following the pandemic, the prevalence of depression and anxiety is higher in the urban population compared with the rural population in Malaysia. The proportion of the participants with depressive symptoms was 23.9%; anxiety symptoms, 41.7%; and depression with comorbid anxiety symptoms, 19.9% [13]. The discrepancy in the prevalence of anxiety in hospitalized COVID-19 patients between our study and other studies may be attributed to the emergence of psychosocial health problems in a middle-income country. This is supported by the reports emphasizing that the lack of financial and health resources and overcrowding may contribute to more dire consequences in low- and middle-income countries [28].

Anxiety was found to be associated with the severity of COVID-19 in the study, where the prevalence of mild, moderate, and severe anxiety was 84.2, 86, and 94.7%, respectively. This finding was in line with a previous study of hospitalized patients with severe and very severe anxiety [14]. Signs and symptoms of anxiety and depression, such as irritability, despair, abnormally low mood, and discomfort, were demonstrated by COVID-19 patients in isolation wards [29]. This is invariably evident in the increased vulnerability to stress and negative emotions from confined conditions and social isolation. Earlier studies from Wuhan, China, revealed that patients with low oxygen saturation related to the severe COVID-19 category were likely to have higher anxiety scores [2]. There was a significant association between the severity of COVID-19 infection with anxiety in this study, whereby category 3 had the highest proportion of anxiety (92.3%) followed by category 5 (90.9%) and category 2 (87.5%), respectively. Although this study did not specifically ascertain the level of oxygen saturation during the study recruitment, the category of the patient's severity was a more objective determinant as oxygen saturation may show a variable fluctuation during the course of the hospitalization.

4.2. Risk factors for anxiety

Anxiety symptoms result in clinically significant distress in the social and occupational life domains. Thus, it was not surprising that this study found that employment status was significantly different between the COVID-19 group and the controls, whereby

TABLE 2 Comparison of the variables between the study population and controls.

| | Group | N | Percentiles | | | | U | p |
			50th (Median)	25th	75th	IQR		
Age (years)	Control	105	56.00	37.50	68.00	30.50	6180.00	0.975
	Covid 19	118	54.00	40.75	65.00	24.25		
GAD-7 Score	Control	105	1.00	0.00	2.00	2.00	1410.50	0.001*
	Covid 19	118	8.00	7.00	14.00	7.00		
Length of hospitalization	Control	105	10.00	5.00	17.50	12.50	5163.50	0.032*
	Covid 19	118	12.00	8.00	20.25	12.25		
Hemoglobin level (g/dL)	Control	105	12.10	10.15	14.05	3.90	5062.50	0.019*
	Covid 19	118	13.40	11.48	14.73	3.25		
White cell count $\times 10^9$/L	Control	105	10.30	8.05	15.10	7.05	4108.50	0.001*
	Covid 19	118	8.50	5.98	10.50	4.53		
Platelet $\times 10^9$/L	Control	105	276.00	208.00	345.00	137.00	4881.50	0.006*
	Covid 19	118	236.50	177.75	289.00	111.25		
Sodium mmol/L	Control	105	136.00	133.00	139.00	6.00	5174.00	0.033*
	Covid 19	118	135.00	131.00	138.00	7.00		
Potassium mmol/L	Control	105	4.00	3.70	4.40	0.70	5264.50	0.053
	Covid 19	118	3.90	3.58	4.30	0.73		
Urea mmol/L	Control	105	5.50	3.80	10.20	6.40	5619.00	0.231
	Covid 19	118	4.90	3.30	7.63	4.33		
Creatinine µmol/L	Control	105	97.20	75.65	180.40	104.75	5196.00	0.038*
	Covid 19	118	86.80	72.75	129.83	57.08		
Total protein g/L	Control	105	71.00	65.50	78.00	12.50	6172.50	0.963
	Covid 19	118	72.50	66.00	78.00	12.00		
Albumin g/L	Control	103	33.00	27.00	38.00	11.00	6031.00	0.923
	Covid 19	118	33.00	29.00	37.00	8.00		
Bilirubin µmol/L	Control	105	12.30	8.65	18.90	10.25	5401.50	0.099
	Covid 19	118	10.55	8.40	15.75	7.35		
Alanine transaminase IU/L	Control	105	22.00	14.50	41.50	27.00	4850.00	0.005*
	Covid 19	118	32.50	18.00	65.00	47.00		
Alkaline phosphatase IU/L	Control	105	89.00	70.50	121.50	51.00	4975.50	0.011*
	Covid 19	118	76.50	60.00	100.00	40.00		

*Significant $p < 0.05$. U Mann–Whitney U test; IQR, interquartile range; GAD-7, Generalized Anxiety Disorder-7.

the employed group had higher anxiety levels. Employment is crucial for psychological wellbeing as it fulfills essential needs such as social support, self-development, self-efficacy, and quality of life (30). Psychological health analysis among Chinese employees following the COVID-19 outbreak found a positive and significant impact of job insecurity on depression and anxiety (30). A cross-sectional online survey found that about 50.5% of Japanese workers felt anxious about being infected with COVID-19 in the workplace (31). A similar pattern of work-related distress was reported by employees in Serbia, where 63.4% of participants expressed increased levels of distress. This was related to moderately or highly insecure employment (30.4%) and losing their jobs (15.1%) (32). Higher distress scores were seen with increasing job insecurity, intolerance of uncertainty, and fear of COVID-19. A study in the United States gleaning the mental health burden among young adults found that job insecurity stemming from the loss of jobs and expected job loss could increase symptoms of anxiety and depression (33). The relationship between the effects of COVID-19 on the impact on employment invariably leads to poorer mental health worldwide. Further analysis of the subtypes of employment in this study may elucidate the moderating effect of intolerance of uncertainty on individual psychological factors.

Although most of the clinical features of COVID-19 are respiratory, cardiac, or gastrointestinal, many patients also experience neuropsychiatric manifestations. These manifestations stem from the direct effects on the nervous system or para-infectious/postinfectious immune-mediated disorders. Psychological stressors occur from social isolation, fear of illness, stigma, and future uncertainty from the disease. Several postulated mechanisms that have been proposed for nervous system damage

TABLE 3 Distribution of the demographic, clinical characteristics, and laboratory investigations of the study population with anxiety.

			GAD7			
		Total	Control	COVID-19		
			n (%)	n (%)	χ^2	p
Demographic variable						
Age group (years)	15–64	157	71 (45.2)	86 (54.8)	0.43	0.514
	>65	66	33 (50)	33 (50)		
Gender	Male	141	67 (47.5)	74 (52.5)	0.12	0.729
	Female	82	37 (45.1)	45 (54.9)		
Marital status	Single	41	20 (48.8)	21 (51.2)	0.09	0.761
	Married	182	84 (46.2)	98 (53.8)		
Ethnic group	Malay	138	66 (47.8)	72 (52.2)	1.31	0.727
	Chinese	52	22 (42.3)	30 (57.7)		
	Indian	18	10 (55.6)	8 (44.4)		
	Others	15	6 (40)	9 (60)		
Habits	None	182	89 (48.9)	93 (51.1)	6.58	0.087
	Smoking	34	15 (44.1)	19 (55.9)		
	Alcohol	2	0 (0)	2 (100)		
	Smoking and Alcohol	5	0 (0)	5 (100)		
Education level	None	6	3 (50)	3 (50)	2.75	0.432
	Primary	58	31 (53.4)	27 (46.6)		
	Secondary	133	56 (42.1)	77 (57.9)		
	University	26	14 (53.8)	12 (46.2)		
Employment	Unemployed	138	76 (55.1)	62 (44.9)	10.35	0.001*
	Employed	85	28 (32.9)	57 (67.1)		
Diagnosis of COVID-19	No	105	89 (84.8)	16 (15.2)	115.90	0.001*
	Yes	118	15 (12.7)	103 (87.3)		
COVID-19 category	Non-COVID	105	89 (84.8)	16 (15.2)	116.74	0.001*
	Category 1	8	2 (25)	6 (75)		
	Category 2	16	2 (12.5)	14 (87.5)		
	Category 3	26	2 (7.7)	24 (92.3)		
	Category 4	57	8 (14)	49 (86)		
	Category 5	11	1 (9.1)	10 (90.9)		
Clinical characteristics						
Respiratory symptoms (fever, runny nose, sore throat, shortness of breath, and cough)	No	57	39 (68.4)	18 (31.6)	14.60	0.001*
	Yes	166	65 (39.2)	101 (60.8)		
Fever	No	99	55 (55.6)	44 (44.4)	5.69	0.017*
	Yes	124	49 (39.5)	75 (60.5)		
Runny nose	No	205	103 (50.2)	102 (49.8)	11.54	0.001*
	Yes	18	1 (5.6)	17 (94.4)		
Sore throat	No	193	101 (52.3)	92 (47.7)	17.03	0.001*
	Yes	30	3 (10)	27 (90)		
Shortness of breath	No	155	83 (53.5)	72 (46.5)	8.87	0.003*
	Yes	68	21 (30.9)	47 (69.1)		

(Continued)

TABLE 3 (Continued)

			GAD7			
		Total	Control	COVID-19		
			n (%)	n (%)	χ²	p
Cough	No	134	85 (63.4)	49 (36.6)	38.06	0.001*
	Yes	89	19 (21.3)	70 (78.7)		
Gastrointestinal symptoms (diarrhea, vomiting, abdominal pain, and poor oral intake)	No	207	91 (44)	116 (56)	6.87	0.009*
	Yes	16	13 (81.3)	3 (18.8)		
Diarrhea	No	218	102 (46.8)	116 (53.2)	0.00	1.000
	Yes	5	2 (40)	3 (60)		
Vomiting	No	220	101 (45.9)	119 (54.1)	1.65	0.200
	Yes	3	3 (100)	0 (0)		
Abdominal pain	No	216	98 (45.4)	118 (54.6)	2.96	0.085
	Yes	7	6 (85.7)	1 (14.3)		
Poor oral intake	No	219	100 (45.7)	119 (54.3)	2.73	0.098
	Yes	4	4 (100)	0 (0)		
Neurological symptoms (seizures, weakness, headache, and dizziness)	No	181	94 (51.9)	87 (48.1)	10.84	0.001*
	Yes	42	10 (23.8)	32 (76.2)		
Seizures	No	220	102 (46.4)	118 (53.6)	0.01	0.906
	Yes	3	2 (66.7)	1 (33.3)		
Weakness	No	217	102 (47)	115 (53)	0.06	0.805
	Yes	6	2 (33.3)	4 (66.7)		
Headache	No	197	101 (51.3)	96 (48.7)	14.57	0.001*
	Yes	26	3 (11.5)	23 (88.5)		
Dizziness	No	212	100 (47.2)	112 (52.8)	0.49	0.484
	Yes	11	4 (36.4)	7 (63.6)		
Muscle and joint pain	No	206	102 (49.5)	104 (50.5)	8.99	0.003*
	Yes	17	2 (11.8)	15 (88.2)		
Laboratory investigations						
Hemoglobin g/dL	12.0–15.0	99	43 (43.4)	56 (56.6)	0.73	0.392
	Abnormal	124	61 (49.2)	63 (50.8)		
White cell count × 10⁹/L	4.0–10.0	124	53 (42.7)	71 (57.3)	1.70	0.192
	Abnormal	99	51 (51.5)	48 (48.5)		
Platelet × 10⁹/L	150–410	167	78 (46.7)	89 (53.3)	0.00	0.971
	Abnormal	56	26 (46.4)	30 (53.6)		
Sodium mmol/L	136–145	115	61 (53)	54 (47)	3.92	0.048*
	Abnormal	108	43 (39.8)	65 (60.2)		
Potassium mmol/L	3.5–5.1	176	87 (49.4)	89 (50.6)	2.62	0.105
	Abnormal	47	17 (36.2)	30 (63.8)		
Urea mmol/L	2.5–6.7	129	59 (45.7)	70 (54.3)	0.10	0.752
	Abnormal	94	45 (47.9)	49 (52.1)		
Creatinine μmol/L	50.4–98.1	124	53 (42.7)	71 (57.3)	1.70	0.192
	Abnormal	99	51 (51.5)	48 (48.5)		

(Continued)

TABLE 3 (Continued)

			GAD7			
		Total	Control	COVID-19		
			n (%)	n (%)	χ^2	p
Total protein g/L	64–83	170	75 (44.1)	95 (55.9)	1.82	0.177
	Abnormal	53	29 (54.7)	24 (45.3)		
Albumin g/L	34–48	106	47 (44.3)	59 (55.7)	0.43	0.513
	Abnormal	117	57 (48.7)	60 (51.3)		
Bilirubin μmol/L	3.4–20.5	183	88 (48.1)	95 (51.9)	0.86	0.353
	Abnormal	40	16 (40)	24 (60)		
Alanine transaminase IU/L	0–55	180	88 (48.9)	92 (51.1)	1.90	0.168
	Abnormal	43	16 (37.2)	27 (62.8)		
Alkaline phosphatase IU/L	40–150	191	90 (47.1)	101 (52.9)	0.13	0.724
	Abnormal	32	14 (43.8)	18 (56.3)		

*Significant $p < 0.05$; χ^2 Chi-square test.

TABLE 4 Univariate and multivariate logistic regression analysis for anxiety.

Variables	Univariate			Multivariate		
	OR	95% CI for EXP (B)	p	OR	95% CI for EXP (B)	p
Diabetes mellitus	0.51	0.29–0.88	0.015 *	0.71	0.30–1.68	0.434
Employment	2.50	1.42–4.38	0.001 *	1.86	0.75–4.61	0.178
COVID-19 diagnosis	38.20	17.87–81.62	0.001 *	36.92	17.09–79.78	0.001*
Respiratory symptoms	3.37	1.78–6.38	0.001 *	1.74	0.34–8.77	0.504
Fever	1.91	1.12–3.27	0.018 *	0.40	0.12–1.37	0.144
Cough	6.39	3.45–11.84	0.001 *	1.74	0.63–4.77	0.284
Sore throat	9.88	2.90–33.66	0.001 *	0.59	0.11–3.04	0.526
Shortness of breath	2.58	1.41–4.72	0.002 *	0.54	0.18–1.63	0.275
Runny nose	17.17	2.24–131.40	0.006 *	2.193	0.22–22.20	0.506
Neurological symptoms	3.46	1.60–7.45	0.002 *	2.94	1.03–8.41	0.044 *
Headache	8.07	2.35–27.74	0.001 *	0.52	0.06–4.87	0.566
Gastrointestinal symptoms	0.18	0.05–0.65	0.009 *	0.24	0.04–1.56	0.137
Muscle and joint pain	7.36	1.64–32.98	0.009 *	1.40	0.17–11.16	0.753
Sodium	0.59	0.34–1.00	0.049 *	1.66	0.72–3.84	0.239

*Significant $p < 0.05$; OR, odds ratio; 95% CI, 95% confidence interval.

by SARS-CoV-2 infection include direct infection (34), hypoxia injury (35), immune injury (36), and interaction with the angiotensin-converting enzyme receptors (37).

Several papers have explored the various COVID-19 neurological manifestations from China (38), ALBACOVID in Spain (39), the United States (40), France (41), and Malaysia (42). A systemic review of the literature revealed common neurological manifestations: myalgia, taste impairment, smell impairment, headache, and dizziness (43, 44). More severe complications include encephalopathy, encephalitis, cerebrovascular diseases (41, 45) and Guillain–Barre syndrome (46). Mao et al. retrospectively analyzed COVID-19 patients from 3 hospitals (38). They found 36.4% of patients with neuropsychiatric symptoms, which were differentiated

into central (dizziness, headache), peripheral (dysgeusia, anosmia, and muscle pain), and psychological (anxiety, depression, and delirium) (38). Similarly, this study revealed that the main neurological symptoms were seizures, weakness, headache, and dizziness.

Previous literature on mental health in COVID-19 was primarily derived from observational studies (5, 47). The common psychological reactions to the COVID-19 pandemic showed symptoms of anxiety and depression (16–28%) and self-reported stress (8%) and may be associated with disturbed sleep (48). In this study, we evaluated that neurological symptoms had almost thrice the odds of developing anxiety symptoms. The currently available data broadly describe the neuropsychological COVID-19 manifestations

but do not explore the association between both aspects. Our study demonstrated the possibility that anxiety might also be likely related to the underlying complex interplay of neurological features. Several proposed mechanisms that interlink psychopathological factors and immune systems include neuronal injury (49), disruption of the blood–brain barrier, peripheral immune cell invasion into the central nervous system (50) and maladaptive immune systems (51).

Anxiety is often associated with negative outcomes such as poorer prognosis of physical diseases, longer hospitalization, and increased readmission rates in non-psychiatric settings (52). The consequences of anxiety may affect the quality of life of the individual and negatively affect the individual's work, family, and social life, and even lead to suicide (53). The effects of anxiety are often seen in isolation and quarantine wards. The unfavorable psychological effects of quarantine may lead to post-traumatic stress symptoms, bewilderment, and rage (54). The impact of the pandemic on anxiety needs to be apprehended in order to tailor the appropriate psychological and social support.

4.3. Strengths and limitations

The case–control study measured the variables between the cases and controls to evaluate the significant risk factors. We identified that COVID-19 patients with neurological symptoms had a higher risk to develop anxiety, which is a novel finding.

This study was carried out at a single center, which may not be a representative of the wider population of COVID-19 patients. This significant limitation may underestimate the true prevalence of anxiety among this patient group. Moreover, the study cannot determine the temporal relationship between exposure and outcome, which is a key consideration in understanding the development of anxiety. The lack of follow-up of patients after discharge from the hospital precludes any assessment of whether anxiety levels persist over time. The use of only one anxiety assessment questionnaire limits the ability to compare anxiety levels with other validated tools.

5. Conclusion

This study compared patients' characteristics, clinical features, and anxiety levels concerning COVID-19 patients compared to controls from a tertiary teaching hospital setting. We identified that the burden of anxiety is high among hospitalized COVID-19 patients compared to controls. Those with the presence of neurological symptoms were more likely to suffer from anxiety. Early psychiatric referrals are warranted for patients at risk of having symptoms of anxiety. In addition, the availability of support groups to provide counseling assistance to hospitalized COVID-19 patients may help to facilitate support intervention programs.

Data availability statement

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

Ethics statement

The studies involving human participants were reviewed and approved by Research and Ethics Board, Faculty of Medicine, National University of Malaysia. The patients/participants provided their written informed consent to participate in this study.

Author contributions

AS and HT: conceptualization, methodology, investigation, formal analysis, and writing—original draft. CK: investigation, formal analysis, and writing—original draft. CN: methodology, investigation, formal analysis, and writing—review and editing. WZ: methodology, investigation, and writing—review and editing. NK and PP: data acquisition, formal analysis, and writing—review and editing. CE and AP: data acquisition and writing—review and editing. RH and HT: methodology and writing—review and editing. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted without any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyt.2023.1148019/full#supplementary-material

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Posttraumatic stress disorder symptoms among healthcare workers during the Omicron era

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Background: The COVID-19 pandemic has caused significant psychological stress among healthcare workers. This study aimed to clarify the factors that influenced health workers' posttraumatic stress disorder (PTSD) symptoms.

Method: A total of 443 healthcare workers from eight Mental Health Centers in Shandong were recruited to attend an online survey. Participants completed self-evaluation measures of exposure to the COVID-19 environment and PTSD symptoms, as well as measures of potential protective factors such as euthymia and perceived social support.

Results: About 45.37% of healthcare workers had severe symptoms of PTSD symptoms. Healthcare workers with more serious PTSD symptoms were significantly related to higher exposure to COVID-19 ($r=0.177$, $p<0.001$), as well as lower levels of euthymia ($r=-0.287$, $p<0.001$) and perceived social support ($r=-0.236$, $p<0.001$). The structural equation model (SEM) further revealed that the impact of exposure to COVID-19 on PTSD symptoms was partially mediated by euthymia, and moderated by perceived social support, especially from others (e.g., friends, leaders, relatives and colleagues).

Conclusion: These findings suggested that improving the state of euthymia, getting social support from others could alleviate PTSD symptoms among healthcare workers during the COVID-19.

KEYWORDS

exposure to COVID-19, euthymia, posttraumatic stress disorder symptoms, perceived social support, healthcare workers

Introduction

At the beginning of 2022, the Omicron variant rapidly spread in China. As of March 2022, there were 5,559 new cases of asymptomatic infections nationwide. Of these, over 5,000 cases of native infection have been reported, with Shandong Province ranking eighth in terms of the number of increases (1). Shandong, the second most populous province in the country (2), provided a conductive environment for its spread. The outbreak firstly started in Qingdao and quickly spread to other cities in Shandong. Many places implemented strict closure policies to

try to control the spread of the virus. By the end of March 2022, the cumulative number of asymptomatic infectors in Shandong had reached 2,175 cases (3).

The COVID-19 pandemic has caused serious mental health problems among the general public (4). Healthcare workers, as a major force in the fight against the COVID-19 pandemic, have been suffering from high risks of infection and increasingly heavy workloads (5, 6). These factors have inevitably caused damage to their mental health. For instance, previous studies have found that healthcare workers had severe anxiety, depression and stress (7, 8). Moreover, a global review study on the mental health of healthcare workers showed that the prevalence of post-traumatic stress disorder (PTSD) in the healthcare population has reached 49%, which was much higher than anxiety (40%) and depression (37%) (9). It was clearly that PTSD symptoms have become a key issue in the mental health of healthcare workers during the COVID-19 pandemic (10).

PTSD could occur after individual experienced a life-threatening trauma. It is a trauma- and stressor-related disorder, the symptoms of which are mainly persistent intrusive memories, avoidance of trauma-related stimuli and hyperarousal to stimuli associated with the traumatic event (11). PTSD could increase the risk of poor physical health (12) and suicide (13, 14). Besides, it has been found to be associated with severe psychiatric co-morbidity (15, 16) and has a long-term negative impact on family life (17). One recent study tracking the mental health of healthcare workers in Guangzhou found that 1 year after the outbreak of COVID-19, healthcare workers still showed symptoms of PTSD, with the prevalence of the disorder even increasing from 10.73 to 20.84% (18). Further, severe PTSD symptoms have been linked to high turnover intention among nurses (19). This could pose a great threat to the health system's ability to provide adequate care. As a result, it was particularly important to explore the factors that influenced the development of PTSD symptoms.

Overexposure to the COVID-19 pandemic has been proven to be a risk factor for mental health problems (20). Studies have shown that the duration and frequency of exposing to COVID-19-related information were positively associated with levels of anxiety and depression (21). Specifically, overexposure to the COVID-19 information increased individual emotional distress, such as threat, anxiety and depression, and risk perception mediated the relationship between the two factors (20). Some studies have also shown that the negative effect of overexposure to COVID-19 on PTSD symptoms (5, 19, 22), highlighting the mediating role of perceived threats and feelings of vulnerability (22). However, researches on the relationship between exposure to COVID-19 and PTSD symptoms were still lacking. Few studies explored the role of positive psychological states in the process, such as the euthymia and social support. Euthymia is a comprehensive measure of positive mental health (23), which is characterized by the absence of emotional impairment in an individual mental health, flexibility, and resistance to stress (24). Previous researches showed that the Euthymia Scale could detect individual susceptibility to depression (25). The worse the euthymia, the more likely the individual was to develop depressive symptoms. Besides, social support has been proposed to be effective in dealing with mental health impairments (26, 27). For instance, social support could buffer the impact of traumatic events by moderating an individual's ability to perceive the traumatic event and then to reduce negative thoughts or by increasing an individual's resources to combat stress (28, 29). As with social support, euthymia may also buffer PTSD symptoms during overexposure to the COVID-19 environment. To this end, the impact of euthymia and social support on the release of PTSD symptoms caused by overexposure to COVID -19 remained to be explored.

To fill in these gaps, we conducted an online survey on healthcare workers to clarify the relationship among exposure to COVID-19, social support, euthymia state and PTSD symptoms. We aimed to provide evidences supporting that social support and euthymia could alleviate the effect of overexposure on PTSD symptoms. This study could provide useful suggestions for the daily care and treatment of healthcare workers, even after the pandemic.

Methods

Participants

This online study was conducted among healthcare workers in eight mental health centers in Shandong Province, most of whom were from the psychiatric departments. We chose these centers because the healthcare workers who worked there have had closely contact with patients confirmed to be infected with COVID-19. We contacted around 800 people and eventually received 725 completed online questionnaires. The attrition rate of our study was approximately 9.38%. All of them voluntarily completed the questionnaires and were not paid for their participation. To improve the reliability of results from the subsequent analysis, participants who failed to pass the quality control questions were excluded, leading to a valid rate of 61.10% (443 participants). The study was approved by the Ethics Committee of the Shandong Mental Health Centre. All participants provided informed consent prior to the survey.

Questionnaires

To measure healthcare workers' exposure to COVID-19, we developed a questionnaire including the following questions:(1) Have you ever been informed of a positive test result of COVID-19; (2) Has anyone close to you (e.g., relatives, colleagues, neighbors) ever been confirmed as COVID-19 positive; (3) Have you ever been isolated because you had symptoms of COVID-19 or closely contacted with infected people; (4) Has anyone close to you (e.g., relatives, colleagues, neighbors) ever been isolated because of symptoms of COVID-19 or close contacts; (5) Have you ever worked in a mobile cabin hospital, community or isolated site; (6) Overall, did you think healthcare workers are at higher risk of infection; (7) Which type of controlled area you currently live in; (8) How much time you spent on receiving the information related to COVID-19 every day. The 1–6 questions were scored dichotomously as 1 (yes) or 0 (no). In the seventh question, choosing "Precautionary Zone" was scored as 0, "Controlled Zone" as 1 and "Locked-down Zone" as 2. In the final question, 0 marked for "<30 min/day," 1 marked for "30–60 min/day," 2 marked for "60–180 min/day" and 3 marked for ">180 min/day." This questionnaire has not been subjected to any reliability assessment.

The Impact of Events Scale (IES-R) with 22 items in total was used to assessed the subjects' PTSD symptoms in the last 7 days after experiencing a traumatic event (30). Here, we indicated the experience relating to COVID-19 as the sole event to be considered. The

questionnaire consisted of three different dimensions: avoidance (8 items), intrusion (8 items), and hyperarousal (6 items). Each item had a score of 0 (Not at all) to 4 (Always), with a total score of 0 to 88. The higher the score, the more serious were PTSD symptoms. Among them, those with a total score of greater than 22 were considered to have significant PTSD symptoms [31]. In our study, the coefficient of internal consistency (Cronbach's α) was 0.970.

The Chinese version of the Perceived Social Support Scale (PSSS) was adapted by Jiang Qianjin and his colleagues in 1996 [32], which measured individual perceived social support from two dimensions: family and others (including friends, leaders, relatives and colleagues). There were 12 questions in total and measured on a seven-point Likert scale (1–7, with labels of 'extremely disagree' to 'extremely agree'), with a total score of 12 to 84 [32]. The higher total score, the higher level of perceived social support. In the current study, the Cronbach's α was 0.964.

The Euthymia Scale was used to assess individual state of euthymia, contributing to predict positive dimensions of mental health [24]. It was multidimensional measurement of psychological well-being and resilience [33]. Recently, this scale has been translated into Chinese by Professors Yonggui Yuan and Yuqun Zhang [25]. The scale consisted of 10 items, with a score of 1 for "true" and 0 for "false." The higher the score, the better the individual psychological state. The Cronbach's α was 0.857 in this study.

Statistical analysis

The IBM SPSS 26.0 and Mplus 8.3 software were used to analyze data. We divided subjects into low (without obvious PTSD symptoms) or high (with significant PTSD symptoms) groups based on whether the total IES-R score exceeded 22 points. Firstly, we conducted a descriptive statistical analysis of the demographic characteristics between two groups. Secondly, we investigated the relationship between any two of the four factors (i.e., euthymia, perceived social support, exposure to COVID-19 and PTSD symptoms) using Spearman's rank correlation for all qualified participants. Based on the same data, we constructed a structural equation model to explore the role of euthymia and perceived social support in the relationship between overexposure to COVID-19 and PTSD symptoms. Goodness of the model fit was assessed by comparative fit index (CFI > 0.90), Tucker-Lewis index (TLI > 0.90), root mean square error of approximation (RMSEA<0.08) and standardized root mean residual (SRMR<0.08) [34, 35]. The significant threshold was set to $p < 0.05$.

Results

Demographic information

As Table 1 showed, the mean age of the 443 participants was 35 (SD = 9.421). Of these, 300 were female (67.72%) and 143 were male (32.28%). 286 participants (64.56%) obtained a bachelor's degree or higher. 237 participants (53.50%) had an annual income of at least 100,000 RMB. Of these 443 participants, 102 (23.02%) went to the front line (quarantine sites, square cabin hospitals, etc.) to provide support.

Groups with high vs. low PTSD symptoms

According to our criteria, 43.37% of our participants had severe PTSD symptoms, mostly manifesting as intrusion symptoms (Table 1). We then compared demographic statistics between two groups with high or low PTSD symptoms (Table 1). No significant difference was observed on educational year ($X^2 = 0.002$, $p = 0.963$), gender ratio ($X^2 = 0.781$, $p = 0.377$) and annual income ($X^2 = 3.327$, $p = 0.068$). Nevertheless, the mean age of the high group was greater than the low group ($t = 2.061$, $p = 0.040$). To avoid the interpretation of our follow-up results by it, age was controlled as a covariate in the subsequent analysis. We additionally found that greater exposure to COVID-19 ($F = 8.811$, $p = 0.003$), lower euthymia ($F = 24.179$, $p < 0.001$) and perceived social support ($F = 16.267$, $p < 0.001$) in the high group compared to the low group (Figure 1).

Correlations between PTSD symptoms and other factors

When it comes to correlations among PTSD symptoms and other factors, there was a significant positive correlation between the COVID-19 exposure and PTSD symptoms ($r = 0.177$, $p < 0.001$). Besides, the euthymia ($r = -0.287$, $p < 0.001$) and perceived social support ($r = -0.236$, $p < 0.001$) were also significantly correlated with the level of PTSD symptoms. However, no significant relationship was found between the exposure and perceived social support ($r = -0.048$, $p = 0.311$).

To further explore which aspects of PTSD symptoms were associated with these factors, we then assessed their correlations with each subscale of IES-R. We found higher levels of COVID-19 exposure predicted higher levels of intrusion ($r = 0.200$, $p < 0.001$), avoidance ($r = 0.138$, $p = 0.004$) and hyperarousal ($r = 0.159$, $p = 0.001$). The level of intrusion ($r = -0.283$, $p < 0.001$), avoidance ($r = -0.250$, $p < 0.001$) and hyperarousal ($r = -0.301$, $p < 0.001$) increased when euthymia decreased. Besides, the level of intrusion ($r = -0.239$, $p < 0.01$), avoidance ($r = -0.204$, $p < 0.001$) and hyperarousal ($r = -0.253$, $p < 0.001$) showed significant negative correlations with perceived social support (Table 2).

Structural equation modeling

To explore the relationship among the exposure to COVID-19, PTSD symptoms and possible protective effects of euthymia and perceived social support, we developed structural equation models. First of all, we examined the effect of COVID-19 exposure on PTSD symptoms ($\beta = 0.813$, $p < 0.001$) based on all qualified participants. The IES-R scores served as the potential dependent variable consisting of three dimensions (i.e., avoidance, intrusion and hyperarousal). Then, we investigated the roles of protective factors in this pathway. When euthymia was added to the model, results revealed that euthymia significantly mediated the effect of exposure on PTSD symptoms ($\beta = 0.221$, $p = 0.001$). That is, the higher exposure to COVID-19 was directly and negatively related to individual euthymia ($\beta = -0.319$, $p < 0.001$), which was further correlated with more pronounced PTSD symptoms ($\beta = -0.692$, $p < 0.001$). Overall, the model fitted well with CFI = 0.993, TLI = 0.987, RMSEA =0.056, SRMR = 0.020. After adding

TABLE 1 Demographic information and questionnaire measurements.

	Low group(N=242)	High group(N=201)	Statistics	p
Gender (%)			$X^2 = 0.781$	0.377
Male	83(34.29%)	61(30.34%)		
Female	159(65.70%)	140(69.65%)		
Education (%)			$X^2 = 0.002$	0.963
Below bachelor's degree	86(35.53%)	71(35.32%)		
Bachelor or above	156(64.87%)	130(64.67%)		
Income (%)			$X^2 = 3.327$	0.068
<¥100,000/year	103(42.56%)	103(51.24%)		
>¥100,000/year	139(57.43%)	98(48.75%)		
Age (Mean ± SD)	34.36 ± 9.481	36.21 ± 9.269	$t = -2.061$	0.040
IES-R score (Mean ± SD)	8.86 ± 7.367	37.12 ± 13.153	$F = 799.648$	
Intrusion	3.88 ± 3.116	14.36 ± 5.210	$F = 672.812$	<0.001
Avoidance	3.08 ± 3.195	13.45 ± 5.187	$F = 652.431$	<0.001
Hyperarousal	1.88 ± 2.241	9.29 ± 4.210	$F = 548.506$	<0.001
PSSS (Mean ± SD)	67.12 ± 13.039	62.43 ± 11.974	F = 16.267	<0.001
Family	22.74 ± 4.741	21.04 ± 4.582	$F = 15.972$	<0.001
Others	44.37 ± 8.648	41.38 ± 8.059	$F = 14.589$	<0.001
Euthymia (Mean ± SD)	8.67 ± 2.213	7.56 ± 2.700	$F = 24.179$	<0.001
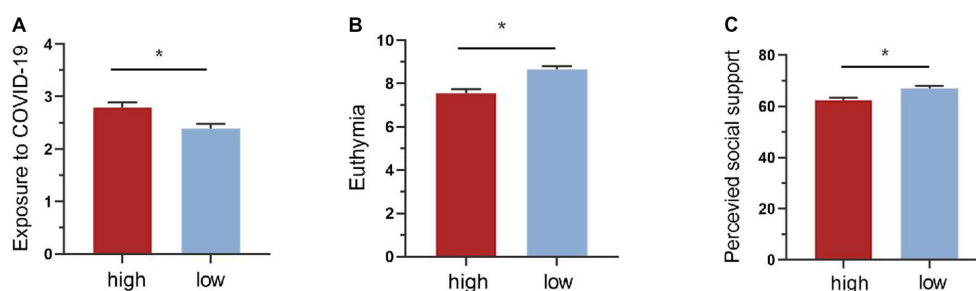
FIGURE 1
Comparison of groups with low and high PTSD symptoms on exposure, euthymia and perceived social support. **(A)** Comparison of the level of exposure to COVID-19 between groups with low and high PTSD symptoms. The group with high PTSD symptoms showed much more exposure. **(B)** Comparison of euthymia between groups with low and high PTSD symptoms. Compared to the low group, high group decreased significantly on the level of euthymia. **(C)** Comparison of perceived social support between groups with low and high PTSD symptoms. The high group perceived lower level of social support than the low group. *p<0.05.

social support to the model, the fit remained well with CFI = 0.982, TLI = 0.975, RMSEA = 0.062, SRMR = 0.042. Perceived social support was found to moderate the effect of COVID-19 exposure on PTSD symptoms ($\beta = -0.110$, $p = 0.030$). In particular, healthcare workers who overexposed to COVID-19 tended to show more PTSD symptoms when perceived social support levels were low ($\beta = 1.445$, $p = 0.002$). However, such effect was decreased at high levels of perceived social support ($\beta = 0.171$, $p = 0.643$) (Figure 2). Overall, the direct effect of overexposure to COVID-19 on PTSD symptoms decreased when individuals perceived high level of social support.

To further investigate which sub-dimensions drove this moderating effect of perceived social support, we developed models based on different sources of support (i.e., family and others) and only found that perceived social support from others ($\beta = -0.112$, $p = 0.029$)

moderated the direct effect of overexposure to PTSD symptoms, neither from family ($\beta = -0.549$, $p = 0.069$) (Figure 3). Besides, the model including perceived social support from others had a good fit with CFI = 0.982, TLI = 0.975, RMSEA = 0.061, SRMR = 0.042. These results suggested that increasing perceived social support, especially from others, and euthymia may protect healthcare workers from falling prey to PTSD symptoms.

Discussion

This study highlighted the high prevalence of PTSD symptoms among healthcare workers during the COVID-19 pandemic. We found that healthcare workers with higher PTSD

TABLE 2 Descriptive analysis and inter-correlations of all need variables.

Factors	Mean	SD	EC	Eu	SS	IES	IS	AD	HA
EC	2.58	1.372	1						
Eu	8.16	2.504	−0.143*	1					
PSS	64.99	12.769	−0.048	0.261*	1				
IES	21.68	17.500	0.177*	−0.287*	−0.236*	1			
IS	8.64	6.698	0.200*	−0.283*	−0.239*	0.963*	1		
AD	7.79	6.668	0.138*	−0.250*	−0.204*	0.953*	0.871*	1	
HA	5.25	4.940	0.159*	−0.301*	−0.253*	0.932*	0.872*	0.841*	1

EC, exposure to COVID-19; Eu, euthymia; PSS, perceived social support; IES, impact of events scale; IS, intrusion; AD, avoidance; HA, hyperarousal.
SD, standard deviation. The significant threshold was set to $p < 0.05$. *$p < 0.05$.

FIGURE 2
The structural equation model depicting the relationship among exposure to COVID-19, euthymia, perceived social support, and PTSD symptoms.
*$p<0.05$.

symptoms were associated with overexposure to COVID-19 environment, worse euthymia and lower levels of perceived social support. Finally, euthymia and social support affected the effect of COVID-19 exposure on PTSD symptoms in separate mechanisms.

Our results showed that 45.37% of our participants had severe symptoms of PTSD, with the most common symptoms being intrusive thoughts and memories. Compared to previous studies, the prevalence of PTSD symptoms among healthcare workers in this study was relatively high (36), high number of infections (one of the seven provinces with more than 1,000 cases) and shortage of medical resources becoming possible influencing factors. By now, the highest reported prevalence of PTSD symptoms was as high as 71.5% in Chinese healthcare workers (5). However, the study mainly focused on healthcare workers in hospitals with fever clinics and wards for the COVID-19, and 81.3% of the participants were from Hubei province (the province with the worst outbreak in 2019). We also found that higher exposure to COVID-19 was associated with more severe PTSD symptoms. This finding was

consistent with recent studies that have found that higher exposure to COVID-19 (6), like working in the clinic (37), witnessing deaths and injuries (38), treating infected patients (39) and receiving a large amount of information related to the COVID-19 pandemic (40), were associated with adverse psychological outcomes such as PTSD or depression. Overall, people who were more frequently exposed to traumatic events would be more susceptible to developing PTSD symptoms (41, 42). Notably, our study did not stop here, we further clarified the two positive factors that could alleviate PTSD symptoms influenced by overexposure to COVID-19 on healthcare workers in Shandong.

Specifically, we provided evidences supporting the buffering role of euthymia and perceived social support on releasing PTSD symptoms in healthcare workers, albeit in distinct ways. We found that the euthymia acted as a mediator in the relationship between exposure to COVID-19 and PTSD symptoms. That is, healthcare workers with higher level of exposure to the COVID-19 pandemic tended to show poorer euthymia state and more PTSD symptoms. This was similar to previous findings which observed significantly decreased psychological well-being (43),
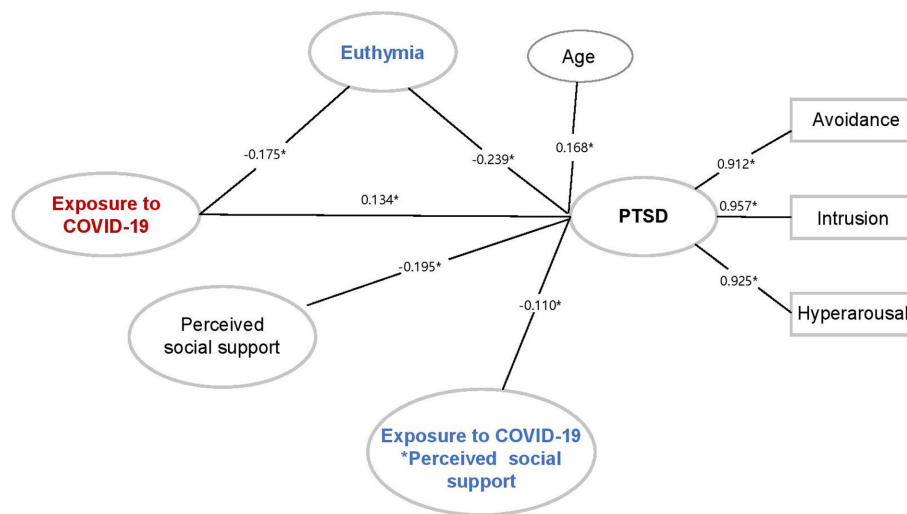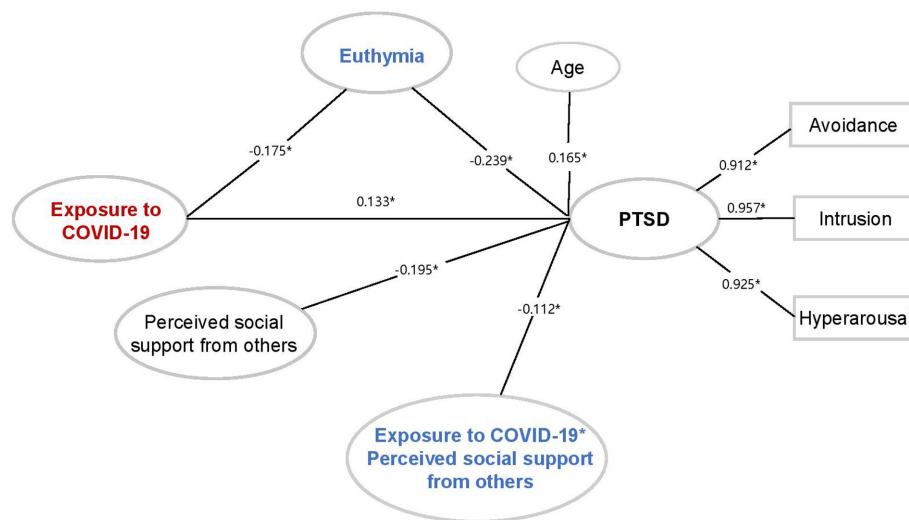
FIGURE 3
The structural equation model describing the relationship among exposure to COVID-19, euthymia, perceived social support from others, and PTSD symptoms. *p<0.05.

the psychological flexibility and the ability to cope with stress (44) during the COVID-19 pandemic, triggering higher levels of anxiety and depression. In other words, the threat of infection, restrictions on social activities, and close contact with infected people could pose a direct threat to individual euthymia state, which may further exacerbate trauma symptoms.

Unlike euthymia, perceived social support was not directly related to exposure to COVID-19. However, it was found to moderated the effect of overexposure to COVID-19 on PTSD symptoms. That is, when perceived social support levels were low, overexposure to COVID-19 increased the possibility of developing PTSD symptoms, but such impact was decreased when levels of perceived social support were high. These findings were in line with the conservation of resources (COR) model, which proposed that social support could broaden an individual's resources to resist stress and protect psychological health (29). Besides, we found that only social support from others such as friends, leaders, relatives and colleagues could mitigate the effect of overexposure on PTSD symptoms. This finding provided additional evidence for the protective effect of perceived social support on psychological health (PTSD, anxiety, depression) (45, 46). Consistent with it, a study of mental health among Polish nurses also found that support from significant others was the main source of social support (47). It was likely that heavy workloads and isolation in hospitals significantly reduced their social interactions with family, which made friends, patients, colleagues and leaders became the most promising sources of social support for healthcare workers.

Despite the positive results presented in this paper, there were several limitations. Firstly, the sample size of the current study was relatively small, further studies with larger sample sizes were need to confirm our conclusions revealed in this paper. Secondly, there was heterogeneity in participants, and their relative mental states may vary depending on their different working load. For instance, previous studies have found that healthcare workers in the Intensive Care Unit (ICU) exhibited more pronounced mental health problems during the COVID-19 (48). Future research could validate the role of social support and euthymia in a more specific group of healthcare workers. Thirdly, the self-measured exposure

questionnaire was designed for this study and lacked reliability and validity tests. Future studies could further optimize items and make it more reliable. Finally, our study focused on PTSD symptoms. Future studies could investigate whether the function of euthymia and social support can be generalized to other emotional distress, such as anxiety and depression.

In conclusion, this study confirmed a close correlation between overexposure to COVID-19 and PTSD symptoms, highlighting specific roles of euthymia and social support in alleviating PTSD symptoms. These results suggested that enhancing social support especially from significant others and increasing levels of euthymia in healthcare workers may be useful for the intervention of PTSD symptoms after the pandemic.

Data availability statement

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

Ethics statement

The studies involving human participants were reviewed and approved by the Ethics Committee of Shandong Provincial Mental Health Centre. The patients/participants provided their written informed consent to participate in this study.

Author contributions

YuY, SH, JG, and DW designed the experiment. YuY, JG, YiY, and SH performed the study. YuY, SH, JG, DW, HW, T-FY, and YiY analyzed the results and wrote the paper together. All authors have read and approved the final version of the manuscript.

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Conflict of interest

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

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Family function and anxiety among junior school students during the COVID-19 pandemic: a moderated mediation model

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Background: The prevalence of anxiety among adolescents is relatively high during an epidemic. Studies have reported that family function and perceived stress are important factors affecting adolescents' anxiety. However, only few studies have explored the factors influencing the relationship between family function and anxiety. Therefore, this study explored the mediating and moderating mechanisms underlying this relationship among junior school student during the COVID-19 pandemic.

Methods: 745 junior school students completed family function, perceived stress, and anxiety questionnaires.

Results: (1) The junior school students that were left-behind tended to show lower family function ($t=-4.21$, $p<0.001$), greater perceived stress ($t=2.72$, $p<0.01$), and higher anxiety ($t=4.24$, $p<0.001$), (2) Family function in junior school students was negatively associated with anxiety ($r=-0.35$, $p<0.001$); perceived stress mediated the relationship between family function and anxiety ($p<0.001$), and (3) Whether the student was left-behind (LB) moderated the link between family function and anxiety ($\beta=-0.16$, $t=-3.33$, $p<0.001$) and between family function and perceived stress ($\beta=-0.22$, $t=-2.61$, $p<0.001$).

Conclusion: These findings suggest a negative association between family function and anxiety. Knowledge of the mediating role of perceived stress and moderating role of being left-behind may help prevent and improve anxiety among junior school students during the COVID-19 pandemic.

KEYWORDS

anxiety, family function, perceived stress, junior school students, COVID-19 pandemic

1. Introduction

In recent years, the pandemic has had a significant impact on the psychological health of adolescent students, the most prominent manifestation of which is that more students are experiencing anxiety symptoms (1–3). A study showed that 54% of adolescent students in China consider their learning and graduation to be affected by the COVID-19 pandemic and have significant anxiety (4). Panda et al. (5) used a meta-analysis to analyze abnormal psychological behaviors among children, adolescents, and caregivers, and the results showed that the incidence of anxiety symptoms during the pandemic period reached 34.5%, particularly among adolescent students. During the epidemic, the level of anxiety among adolescents is relatively high due to various factors. In addition to the stress caused by studying and graduating during the pandemic,

the impact of factors such as the family environment and imbalances in physical and psychological development caused additional stress and also brought many anxieties to adolescents, especially junior school students (6–9). Anxiety is a risk factor for negative behaviors such as violence, addictive behavior, and eating disorders (10). It therefore increases the risk of self-injury and suicide among adolescents (11). Therefore, individual anxiety in junior school students has attracted increasing attention from researchers.

1.1. Family function and anxiety

Ecosystem theory points out that the family growth environment is an indispensable factor that has a significant impact on the healthy growth of children. Family function is an important indicator of the functioning of the family system and is a deep-seated variable that affects the psychological development of family members. Studying the factors that influence family function has important theoretical value and practical significance (12). According to Olson's circular pattern theory, family function is the emotional connection between family members, rules within the family, communication, and interaction between members, and the effectiveness of coping with emergencies. The effectiveness of family function is often related to intimacy and adaptability (13). Studies have shown that family function is significantly correlated with adolescents' emotional health and problematic behavior (14). Adolescents with good family function are less likely to have psychological problems, indicating that family function can significantly and positively predict an individual's mental health level (15). The more complete the family functions, the lower the social anxiety among children and adolescents; incomplete family functions are positively correlated with anxiety (16, 17). Family function plays an important role in influencing individual anxiety, and excessive parental control and lack of emotional expression can lead to high anxiety in adolescents (18).

1.2. Perceived stress as a mediator

Negative thoughts and feelings can generate when an individual experiences great stress in response to stressful life events. Negative thoughts and feelings are known as perceived stress (19). The cognitive theory of stress states that cognitive evaluation is an important factor in individual responses to stress (20), and the results of perceived stress are different due to their cognitive evaluation of stress; when an individual is faced with stress, the effectiveness of stress factors depends on the individual's perceived stress (21). Perceived stress exacerbates negative physical and physiological outcomes (22). Previous studies have shown that family communication between adolescents and children is closely associated with perceived stress (23). Effective family communication can encourage individuals to actively respond to stressful situations and decrease perceived stress (24, 25). The theory of social ecology emphasizes that, when compared to objective social situations, individuals' perceived social psychological situations are more closely related to individual reactions (26). Research has shown that individuals' cognitive levels of stressful events affect their emotional state, and that individuals who perceive more stress are more likely to generate negative emotions (27). The cognitive model of anxiety also indicates that its mechanism is mainly the result of the continuous development of beliefs characterized by a lower sense of control over the environment

(28). Some studies have pointed out that the greater the perceived stress, the easier it is for individuals to experience a sense of tension and loss of control, and therefore have higher their anxiety levels (29).

Accordingly, the following research assumptions are proposed:

> *Hypothesis 1*. Perceived stress mediates the relationship between family function and anxiety in junior school students.

1.3. Left-behind status as a moderator

The mediating model, which examined the relationship between family function and anxiety among junior school students, has important theoretical significance in explaining the internal psychological significance and impact of external events. At the same time, the impact of family function on perceived stress and anxiety may be regulated by other factors, which can better explain the "conditions" of influence among various variables (30). This not only promotes the comparability of research in the research fields of anxiety but also provide ideas for preventing and intervening in negative impacts on family functions concerning anxiety among junior school students in order to find more effective prevention and intervention measures.

Junior school students who are left-behind refer to those who stay at home because their parents or single parents have worked outside for a long time. They are often classified as left-behind children in a broad sense (31). Left-behind children generally refer to children under the age of 18 whose one or both parents emigrated or worked abroad or worked at home or abroad for more than 3 months, and were left in the place of registered residence (32). Research has shown that the disadvantageous situation of parent–child separation makes left-behind junior school students more likely to perceive external pressure (33). At the same time, in the case of parent–child separation, the family functions of left-behind children are negatively affected to varying degrees, which has a negative impact on their mental health; thus, left-behind children are prone to various psychological problems (34–36). Some studies have pointed out that compared to non-left-behind junior school students, left-behind junior school students generally have poorer family functions and more problematic behaviors (29, 37). During the pandemic, left-behind children may not be with accompanying parents at home, however, even with accompanying parents, the family function of left-behind children has not been improved perhaps due to factors such as the quality of parental participation and the formation of parental attachment (38). There is significant negative correlation between family function and mental health, e.g., anxiety among left-behind high school students (39). Some studies have shown that a lack of family function in left-behind children can lead to more negative emotional experiences, which can lead to depression and anxiety (40). Compare to non-left-behind adolescents, the effect of family function on prosocial behavior through peer acceptance was stronger than those former/present left-behind adolescents (41), and emotions themselves are behavioral dynamics (42), those can be considered that it is inherently related to behavior. Thus, this study proposes the following hypotheses:

> *Hypothesis 2*: Being left-behind by parents moderates the relationship between family function and anxiety among junior school students.

Family function is a part of the family environment (43). The lifelong development model of the relationship between stress and
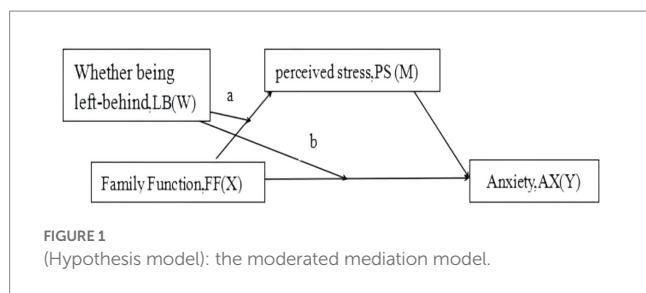
TABLE 1 Descriptive statistics and correlations.

Variables	M	SD	1	2	3
1 perceived stress	2.66	0.83	1		
2 Family function	3.01	0.71	−0.21***	1	
3 Anxiety	2.09	0.51	0.34***	−0.35***	1

$N = 745$; M, mean; SD, standard deviation; *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

health indicates that adverse family environments such as apathy or neglect experienced by individuals in their early stages can reduce their psychological resources, such as positive beliefs related to optimism (44), and the positive beliefs associated with optimism leads to a lesser response to stress, that is, stress events are less likely to be perceived by individuals (45). According to the model of "delivering charcoal in the snow" proposed by Li Dongping (46), this model believes that individual risk factors play a moderating role in the relationship between ecological resource factors and social adaptation. The developmental disadvantage of individuals with high individual risk is reflected more in the situation of low ecological resources rather than high ecological resources, compared to those with low individual risk. According to this model, compared to junior school students who were not left-behind, left-behind junior school students experienced a faster decrease in stress perception as their family functions improved. Thus, we propose the following hypotheses:

> *Hypothesis 3*: Being left-behind by parents moderates the relationship between family function and perceived stress among junior school students.

Based on these theories and research assumptions, this study proposes the following mediated model: (Figure 1). Specifically, family function of junior school students not only directly predicts anxiety, but also affects anxiety levels through perceived stress, i.e., there is an impact path of family function→ perceived stress→ anxiety. At the same time, left-behind status plays a moderating role between family function and anxiety as well as between family function and perceived stress.

2. Measures

2.1. Participants

A total of 745 participants (55.17% female) were included in the analysis. The sample was composed of first-(33.56%), second-(33.42%), and third year (33.02%) students; 41.61% of the participants were junior school students who were left-behind.

2.2. Family function

The family function scale consisted of 20 items (e.g., "Respect friends of other family members"). It was originally developed by Olson et al. in 1985 (13) to evaluate individuals' levels of family function, and the Chinese version was revised in the context of Chinese culture by Xu Jie, Fang Xiaoyi, et al. (47) to include two dimensions: family affinity and adaptability. All responses were measured on a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree). In the present study, the reliability coefficient of the scale was 0.88.

2.3. Perceived stress

The Chinese version (48) of the perceived stress Scale (49) was used to measure participants' levels of perceived stress, it consisted of 14 items (e.g., "Feel nervous and stressed"). Individuals rated each item on a 5-point Likert scale (1 = Never,5 = Always), α = 0.85.

2.4. Anxiety

The Self-rating anxiety scale (50) was initially developed by Zung in 1971 for evaluating anxiety. The Chinese version (51) was revised by Wang et al. The scale consisted of 20 items (e.g., "easy to be upset") and all items were measured on a 4-point Likert scale (1 = Never, 4 = Always). In this study, the reliability coefficient of the scale was 0.86.

3. Data analysis

SPSS23.0 was used to analyze the data. Pearson's correlation coefficient was used for descriptive statistics. The PROCESS Models 4 and 8 macros for SPSS were used to test the mediation and moderated mediation models, respectively. Indirect and direct effects were estimated using 5,000 bootstrap samples. Significance was evaluated using 95% confidence intervals (CIs). All variables were standardized prior to analysis.

4. Results

4.1. Preliminary analysis

The means, SDs and Pearson correlations among the variables are presented in Table 1. There was a significant negative correlation between family function and perceived stress ($r = −0.21$, $p < 0.001$). Family function was negatively correlated with anxiety ($r = −0.35$, $p < 0.001$). Perceived stress was positively correlated with anxiety ($r = 0.34$, $p < 0.001$).

4.2. Comparison of the three variables

The results showed there was a significant difference in the three variables of perceived stress, family function, and anxiety between

junior school students who were left-behind and those not left-behind. Left-behind junior school students tended to show higher anxiety than the others ($t = 4.24$, $p < 0.001$). The family function level of junior high school students who were left-behind was significantly lower than that of junior high school students who were not left-behind ($t = -4.21$, $p < 0.001$). Junior school students who were left-behind tended to show greater perceived stress than the others ($t = 2.72$, $p < 0.01$).

4.3. Analysis of perceived stress as a mediator

As shown in Table 2, Equation 1 (anxiety), family function was negatively related to anxiety ($\beta = -0.25$, $t = -10.01$, $p < 0.001$). According to Equation 2 (perceived stress) and Equation 3 (anxiety), family function was significant negatively related to perceived stress ($\beta = -0.24$, $t = -5.85$, $p < 0.001$) and significant negatively related to anxiety ($\beta = -0.21$, $t = -8.48$, $p < 0.001$), and perceived stress was significant positively related to anxiety ($\beta = 0.17$, $t = 8.22$, $p < 0.001$). Hypothesis 1 was verified; that is, perceived stress mediates the relationship between family function and anxiety.

4.4. Analysis of left-behind status as a moderator

In Table 2, Equation 4 (perceived stress) examined the moderation effect of left-behind status on path a (Figure 1) ($\beta = -0.22$, $t = -2.61$, $p < 0.001$), while Equation 5 (anxiety) examined the moderation effect of left-behind status on path b (Figure 1) ($\beta = -0.16$, $t = -3.33$, $p < 0.001$).

Simple slopes were probed to further explore the moderating role of being left-behind in the mediation association (Figures 2, 3). Family function had a significant negative effect on perceived stress as well as on anxiety between junior school students who were left-behind and those not left-behind. The effect of family function on perceived stress was stronger for junior school students who are left-behind ($b_{simple} = -0.35$, $t = -5.66$, $p < 0.001$) than for others ($b_{simple} = -0.13$,

$t = -2.25$, $p < 0.05$). The effect of family function on anxiety was stronger for left-behind junior school students ($b_{simple} = -0.28$, $t = -7.96$, $p < 0.001$) than for others ($b_{simple} = -0.13$, $t = -3.82$, $p < 0.001$). Thus, Hypotheses 2 and 3 were verified.

5. Discussion

5.1. Comparison of differences among three variables

The family function of junior school students who are left-behind was significantly lower than that of junior school students who were not left-behind, and their stress perception was significantly higher than that of students who were not left -behind. Compared to these children, the frequency and quality of communication between children who are left-behind and their parents is relatively low (52), leading to emotional apathy among family members, and these students were worried about their learning and living status, therefore were prone to high stress perception, which was precisely due to poor family function.

This study showed that junior school students who were left-behind tended to report greater anxiety than their counterparts, which was consistent with previous studies (53, 54). On the one hand, due to insufficient education and guidance for junior school students who were left-behind, they became introverted and sensitive, were not good at or afraid of communicating with others, and harbored enmity toward others. They were prone to emotional anxiety, nervousness, and difficulty in calming down (55). On the other hand, owing to the impact of pandemic prevention and control, some junior school students who were left-behind lacked the correct guidance of their parents for various types of pandemic information because their parents were unable to stay home. Consequently, panic and anxiety were exacerbated because they were unable to distinguish the authenticity of the information and accurately assess the risk information of the epidemic. As can be seen that the disadvantaged situation of left-behind junior school students still deserves academic attention.

TABLE 2 The mediation model.

Predictors	Equation 1	Equation 2	Equation 3	Equation 4	Equation 5
	(Anxiety)	(Perceived stress)	(Anxiety)	(Perceived stress)	(Anxiety)
	β (95% CI)	β (95% CI)	β (95% CI)	β (95% CI)	β (95% CI)
Grade	0.01 (−0.03, 0.005)	0.05 (−0.01, 0.12)	0.01 (−0.04, 0.04)	0.06 (−0.01, 0.13)	0.01 (−0.03, 0.04)
Gender	0.04 (−0.03, 0.11)	0.01 (−0.11, 0.12)	0.04 (−0.02, 0.11)	0.02 (−0.09, 0.13)	0.05 (−0.01, 0.11)
Family function	−0.25*** (−0.29, −0.19)	−0.24*** (−0.32, −0.16)	−0.21*** (−0.25, −0.15)	−0.22*** (−0.30, −0.14)	−0.19*** (−0.23, −0.14)
perceived stress			0.17*** (0.13, 0.21)		0.16*** (0.12, 0.20)
left-behind status				0.12*** (−0.01, −0.23)	0.09*** (0.02, 0.16)
Family function* left-behind status				−0.22*** (−0.38, −0.05)	−0.16*** (−0.25, −0.07)
R^2	0.12	0.05	0.19	0.06	0.21
F	34.29***	12.05***	44.95***	9.52***	33.79***

Each equation controls the grouping of grade and gender; *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

Interaction between family function and whether being left-behind on perceived stress.

Interaction between family function and whether being left-behind on anxiety.
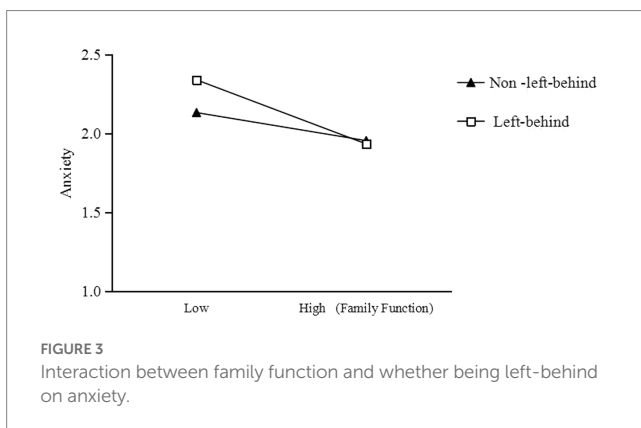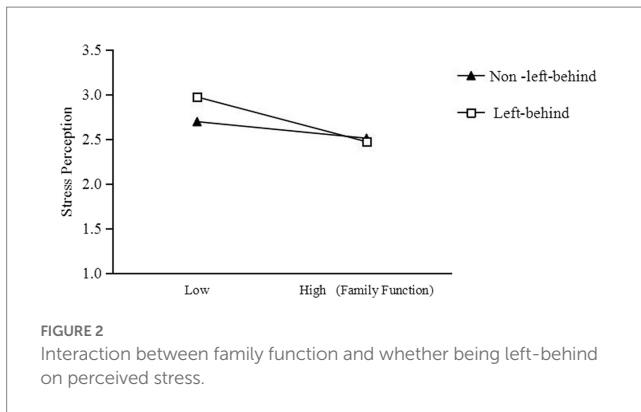
5.2. The mediating effect of perceived stress

The mediating effect indicated that perceived stress was an important bridge between family function and anxiety. Perceived stress was proven to be related to family function. During COVID-19, influenced by risk information, ability to get along with family members, sudden changes in learning styles, social isolation, and other factors influenced junior school students were prone to falling into certain stressful situations, and their mental stress increased significantly (56). In the same stressful situation, some students experienced high levels of stress, while others experienced low levels of stress. That is, compared to students with poor family function, junior school students with good family function might effectively reduce their perceived stress.

The results showed that perceived stress was positively correlated with anxiety, indicating that when junior school students had higher levels of perceived stress, their anxiety levels were also higher, whereas when they had lower levels of perceived stress, their anxiety levels were also lower. This result was consistent with those of previous research results (57–59).

According to the Cognitive Phenomenon Logical Transaction (CPLT) model of stress, the stress response mainly depends on an individual's understanding of the overall relationship between themselves and their environment (20). Therefore, families should not excessively increase their children's academic burden, and provide them with appropriate leisure time to reduce their stress perception (60). Meanwhile, effective measures, such as improving the family

environment of junior school students, should be taken to reduce psychological stress caused by the pandemic, effectively improve family cohesion, and better exert family functions. It was also possible to provide psychological intervention by improving their mental adjustment and coping methods, leading them to form positive values, and helping them positively face stressful situations to reduce negative emotions such as anxiety.

5.3. The moderating effect of left-behind status

Compared to other junior school students, left-behind junior school students' family function was strongly negatively correlated with perceived stress. According to the "delivering charcoal in the snow" model (46) and compared to those with lower individual risks, the disadvantage of individuals with higher individual risks was in the situation of low ecological resources and not in high ecological resources. Therefore, left-behind junior school students exhibited higher stress perception only when their family function was low. Owing to the long-term absence of left-behind junior school students, parents can regularly communicate and exchange ideas through the Internet. Once problems are discovered, parents can quickly find appropriate opportunities to provide creative guidance, helping them view setbacks, gains, and losses with the correct mindset, making them truly realize that their parents are always their strongest source of support, and encouraging them to actively face their lives. Maintaining and strengthening parent–child communication can alleviate the various stresses perceived by children by their parents (60).

Compared to other junior school students, the family function of junior school students who are left-behind was negatively correlated with anxiety. This may be because children who are left-behind have significantly lower family attention than those not left-behind (61), and they crave love and support from their families more urgently. They are eager to receive more emotional communication and understanding between parents (62) to compensate for the negative effects of parent–child separation on children's growth (63). For junior school students who are left-behind with poor family functions, family therapy can be used to reduce their perceived stress and improve their negative emotions; that is, based on the individual situation of junior school students, starting from their past negative experiences, it can be helpful to alleviate their anxiety by changing their cognition and experience of negative family events that occurred in the past, venting their emotions, and rebuilding more adaptive interaction patterns among family members (64), meanwhile, all circles should carry out the lectures of family education, spread scientific educational concepts and help caregivers to change their unscientific family concepts and child views (65).

5.4. Research implications and limitations

This study explored the relationship between family function and anxiety among junior school students. It not only helps us understand how perceived stress affects anxiety among junior

school students but also demonstrates the importance of family function in individual growth. Establishing and maintaining a harmonious parent–child relationship, creating a reasonable family atmosphere, and making the family function play a good role is crucial for the happy growth of junior school students. Through incremental care and emotional support from their parents, children can experience warmth and care for their families. Meanwhile, to improve the family atmosphere and promote good functioning of the family, parents should communicate effectively with their children and establish harmonious parent–child relationships. This is crucial for the growth of junior school students. The moderating role indicated that junior school students who were left-behind need their parents to handle the relationship between material and spiritual support and adopt various channels to strengthen family functions to improve their negative emotions.

This study had certain limitations. First, it only explored the impact mechanism of perceived stress on junior school students' anxiety through cross-sectional research. In the future, longitudinal research will be combined to better clarify the relationship between various variables. Second, our research data were collected in a continuous epidemic situation, reflecting the relationship between variables of the COVID-19 epidemic. With the changes in COVID-19, the relationship between the above variables is tenable remains to be verified.

6. Conclusion

The present study found that direct and indirect relationships between family function and anxiety, as well as left-behind status, simultaneously moderated the mediating effect. To prevent and reduce anxiety among junior school students, improving family function may be coupled with reducing stress perception levels to further mitigate stress onset. When considering the prevention and improvement of anxiety among junior school students who were left-behind, a beneficial approach is to improve family function.

Data availability statement

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

Ethics statement

The studies involving human participants were reviewed and approved by Research Ethics Committee of Shangrao Normal University. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

Author contributions

ZG contributed to the design of the research drafting the manuscript. JZ contributed to the revision of the manuscript. JP contributed to the arranging of materials and data. All authors contributed to the article and approved the submitted version.

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Conflict of interest

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

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Perceived COVID-19 stress and online aggression among Chinese first-year college students: a moderated mediation model

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Purpose: Few studies have explored factors that may account for potential mechanisms between perceived coronavirus disease 2019 (COVID-19) stress and online aggression. The current study examined a moderated mediation model with anxiety as a mediator and perceived anonymity as a moderator.

Methods: A cross-sectional study was conducted. 3,069 participants across China completed scales assessing perceived COVID-19 stress, anxiety, online aggression, and perceived anonymity.

Results: Perceived COVID-19 stress was positively related to online aggression. The association between perceived COVID-19 stress and online aggression was mediated by anxiety. Besides, the relationship between perceived COVID-19 stress and online aggression, as well as the relationship between anxiety and online aggression were moderated by perceived anonymity.

Conclusion: This study explains the possible potential mechanisms for reducing online aggression in the context of COVID-19. In order to intervene in online aggression, psychological strategies are supposed to be drawn to reduce anxiety and perceived anonymity.

1. Introduction

From 13 March to 9 April 2023, 3 million new cases and over 23,000 deaths were reported globally, indicating a declining overall trend (1). However, the report from World Health Organization (WHO) revealed that there had been a significant increase in some regions (1). The coronavirus disease 2019 (COVID-19) epidemic has an ongoing psychological impact on individuals (2–4). COVID-19-related policies (e.g., social distancing and lockdown) have facilitated a shift from offline to online personal life and work. The growth of the internet has enabled people to use online tools to cope with work and academic difficulties, but it has also exacerbated another serious problem: online aggression (5). Prior research revealed that the overall prevalence of online aggression among Chinese college students is 59.47% (6), and COVID-19-related restrictions and influences were related to stronger cyberbullying perpetration (7, 8). First-year students may be severely affected by the epidemic, with evidence of adverse effects of COVID-19 reported by first-year students, many with anxiety, worry, and daily life disruptions (9). Besides, first-year students are in the transition period from high school to university and are at high risk of maladjustment and poor ability to cope with stress (e.g., perceived COVID-19 stress and academic stress, 9).

People who experience cyberbullying may have more internalizing problems (e.g., anxiety and depression), while cyberbullies may be associated with more externalizing problems (e.g., disciplinary violations) (10, 11). Nevertheless, a meta-analysis suggests that internalizing problems (e.g., anxiety) are significant predictors of cyberbullying perpetration (12). Aggression is generally manifested in two forms: instrumental aggression (e.g., individuals are not threatened or hurt and initiate aggressive behavior to gain benefits) and reaction aggression (e.g., individuals are threatened or hurt and engage in retaliatory aggressive behavior) (13, 14). The study focuses on instrumental aggression as it drives people to use aggression to reach goals and achieve benefits, with greater social harm and moral impact. In addition, Zimbardo's deindividuation theory (15) and Barlett and Gentile's (16) learning-based model in cyberbullying perpetration illustrate that individuals' unethical behavior (e.g., online aggression) is associated with low anonymity, and the two may reinforce each other.

We draw the General Aggression Model (GAM, 17) and deindividuation theory (15) to understand the relationship among perceived COVID-19 stress, anxiety, perceived anonymity, and online aggression among Chinese freshmen college students. To our knowledge, few studies exist on the relationship among the above variables. The present study aims to explain the potential mechanisms of perceived COVID-19 stress on online aggression through anxiety and discusses the moderating role of anonymity.

1.1. Perceived COVID-19 stress and online aggression

Although there is no uniform definition of online aggression (Some scholars also refer to it as "cyberbullying"), at its core, it is the act of using electronic technologies against individuals or groups of individuals on the Internet and mobile phone networks to cause harm, which the target seeks to avoid (14, 17). Anderson and Bushman's general model of aggression (18) suggests that personal and situational factors (both referred to as input variables) influence the occurrence of aggression through present internal states (including cognition, affect, and arousal), and Kowalski et al. (17) further explain cyberbullying encountering through this theoretical model. According to the general aggression model, perceived stress is an important personal factor affecting individuals' cognitive and affective states (19, 20). Previous research has shown a strong association between perceived stress and aggression involving adolescents (21), and youth are more likely to engage in bullying behavior (both traditional and online) to respond to stressful life events (22). Empirical evidence supports that stress is significantly associated with verbal aggression and anger (which have a closer relationship with online aggression) (23).

The COVID-19 epidemic is a stressful life event that may be associated with greater aggression in individuals. In the study, perceived COVID-19 stress is defined as the extent to which individuals perceive their lives to be unpredictable, uncontrollable, and overloaded during the COVID-19 epidemic (24, 25). Research has shown that increased perceived stress during the epidemic stimulates aggressive tendencies (26) and is associated with more cyberbullying perpetration (27). Therefore, we proposed that individuals who perceived COVID-19 stress would have more online aggression.

1.2. Anxiety as a mediator

A longitudinal study shows that the percentage of individuals with clinically elevated generalized anxiety was 20% before the outbreak, but rose to 40.4% after the outbreak (28). Previous research finds that COVID-19-related stress has increased the likelihood of mental health issues like anxiety (2). One possible explanation is that perceived COVID-19 stress is a control loss over one's life and may induce anxiety in individuals. Although few studies have directly addressed the relationship between anxiety and online aggression, researchers suggest that anxiety is a precursor to aggression (29), and has a significant and positive correlation with both traditional and online aggression (30, 31). Gu et al. (30) suggest that anxiety may stimulate individuals' sensitivity to negative emotions and amplify their negative experiences, thereby showing an increased frequency of aggression.

Under the general aggression model, COVID-19 stress is considered an input variable that may further lead to the development of individuals' online aggression by influencing their internal states like anxiety (17, 18). In other words, individuals who perceived more COVID-19 stress could experience more anxiety, which may increase their online aggression. Those with higher levels of anxiety are more attentive to negative information and more likely to have impulsive actions (18). Therefore, we proposed that anxiety mediates the relationship between perceived COVID-19 stress and online aggression.

1.3. Perceived anonymity as a moderator

Perceived anonymity is defined as the degree to which individuals perceive themselves and others as anonymous in cyberspace (32). The deindividuation theory suggests that deindividuation refers to the loss of individuation felt by individuals in groups, where their self-control is diminished or absent, which may lead to unconventional antisocial behavior (15, 33). Perceived anonymity is highly correlated with individuals' level of deindividuation, and high anonymity in the online world makes individuals unrestrained, less responsible, and more likely to engage in online aggression (33). The Barlett Gentile Cyberbullying Model (BGCM, 16) and related research (34) support that perceived anonymity is positively related to antisocial online behavior (e.g., online aggression). Furthermore, in the online context, individuals are influenced to develop aggressive urges when the 'instigation' factors associated with aggressive risk are activated, and perceived anonymity acts as an 'impellance' factor for aggressive urges, facilitating this influence and increasing the likelihood of individuals cyberbullying others (35, 36). This means that individuals with high perceived anonymity are more likely to exhibit more online aggression if influenced by input variables associated with aggressive tendencies, such as experiencing stressful life events and anxiety. Specifically, compared to individuals with low perceived anonymity, the effects of perceived COVID-19 stress on online aggression are stronger among individuals with high perceived anonymity. Similarly, the relationship between anxiety and online aggression was stronger in individuals with high perceived anonymity than in individuals with low perceived anonymity. Thus, we proposed that perceived anonymity moderated the relationship between perceived COVID-19 stress and online aggression and the relation between anxiety and online aggression.

1.4. The present study

Previous research has provided evidence of the significant correlations between stress and online aggression. However, no study investigated the relationship between perceived COVID-19 stress and online aggression among Chinese first-year college students. We also discussed the underlying correlation mechanism between perceived COVID-19 stress and online aggression. Based on the literature review, we proposed a conceptual moderated mediation model (see Figure 1) and the following hypotheses:

Hypothesis 1: Perceived COVID-19 stress was positively associated with online aggression.

Hypothesis 2: Anxiety mediated the relationship between perceived COVID-19 stress and online aggression.

Hypothesis 3: Perceived anonymity would moderate the relationship between perceived COVID-19 stress and online aggression.

Hypothesis 4: Perceived anonymity would moderate the relationship between anxiety and online aggression.

2. Materials and methods

2.1. Participants

3,069 participants ($M_{age} = 18.53$, $SD_{age} = 0.70$) were all first-year college students and were recruited from around China. The data was collected from December 2 to December 11, 2022, when China was still in the midst of the COVID-19 epidemic. 42.31% of the participants were male, and 67.61% of the respondents reported that they were from rural areas, while 32.39% were from urban areas.

2.2. Measures

2.2.1. Perceived COVID-19 stress

Perceived COVID-19 stress was measured by the Coronavirus Stress Measure [CSM, (37)], a well-proven questionnaire with good

reliability and validity among Chinese college students (25). The unidimensional questionnaire contains 5 questions on a five-point Likert scale ranging from 0 (never) and 4 (very often) (e.g., "Due to coronavirus, how often have you felt that you were unable to control the important things in your life?"). The higher the score, the higher the perceived COVID-19 stress. In the present study, Cronbach's alpha coefficient of this scale was good ($\alpha = 0.95$).

2.2.2. Online aggression

Online aggression was measured by the instrumental aggression subscale (which was focused on proactive online aggression) of the Chinese version of the Adolescent Online Aggressive Behavior Scale (AOABS, 14). The subscale consists of 15 items and college students rated each item (e.g., "I deliberately disclose other's private information on the internet") on a four-point scale ranging from 1(never) to 4(always). Higher scores represent a higher level of online aggression. For the current study, Cronbach's alpha coefficient of this scale was good ($\alpha = 0.99$).

2.2.3. Anxiety

Anxiety was measured by the anxiety subscale from the Chinese short version of the Depression Anxiety and Stress Scale (DASS-21, 38). The Chinese version of DASS-21 has demonstrated good construct validity and high internal consistency among Chinese college students (38). The anxiety subscale consists of 7 items (e.g., "I felt scared without any good reason"). Respondents rated each item using a four-point scale, ranging from 0 (did not apply to me at all) to 3 (applied to me very much). Higher scores indicate individuals' higher levels of anxiety. In the current study, Cronbach's alpha coefficient of this scale was good ($\alpha = 0.93$).

2.2.4. Perceived anonymity

Perceived anonymity was measured by the Chinese version of the Perceived Anonymity Scale, originally developed by Jung et al. (32) and revised by Niu et al. (39) in Chinese college students. The unidimensional scale contains 4 items (e.g., "People cannot identify true-me from my message in Cyworld") with a seven-point scale ranging from 1 (totally disagree) to 7 (totally agree). A higher score indicates a higher perceived anonymity of the Cyworld, and it is easier for individuals to hide their true selves in Cyworld. In the current study, Cronbach's alpha coefficient of this scale was good ($\alpha = 0.89$).
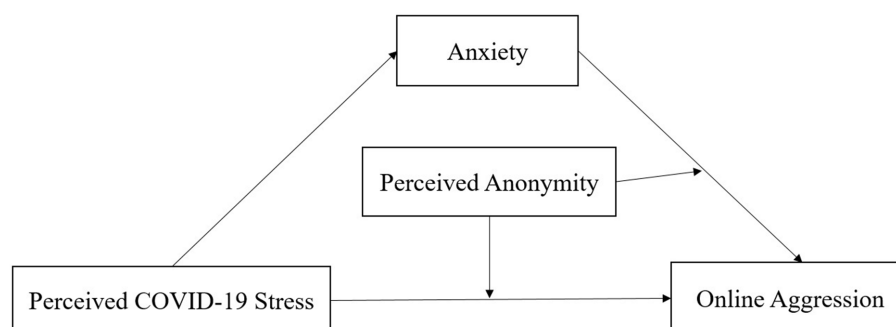
FIGURE 1
The conceptual moderated mediation model.

2.3. Data analysis

We standardized all the data before proceeding with the data analysis. We used SPSS 26 to inspect descriptive statistics and correlations among variables in the preliminary analyses. Then, Hayes's (40, 41) PROCESS macro Model 4 for SPSS was used to test the mediating role of anxiety, and PROCESS macro Model 15 for SPSS was used to test the moderating role of perceived anonymity. 5,000 random sample bootstrapping confidence intervals (CIs) were conducted to test the moderated mediation model with a 95% confidence interval that does not include zero implying a significant effect.

3. Results

3.1. Description statistics and correlations analyses

The descriptive statistics and correlations of all the variables were illustrated in Table 1. All major variables were positively correlated with each other. Specifically, perceived COVID-19 stress was positively related to anxiety and online aggression. Besides, anxiety was positively correlated with online aggression, while perceived anonymity was positively related to perceived COVID-19 stress, anxiety, and perceived anonymity, respectively.

3.2. Testing for the mediation effect

The results of the linear analysis and mediation model were both illustrated in Table 2. Linear analysis of SPSS was used to test hypothesis 1 that perceived COVID-19 stress would be positively

related to online aggression. The results showed that perceived COVID-19 stress was significantly positively related to online aggression ($\beta = 0.41$, $p < 0.001$), which supported hypothesis 1. Then, we used Model 4 of the PROCESS macro to test hypothesis 2 that the effects of perceived COVID-19 stress on online aggression would be mediated by anxiety. Results showed that perceived COVID-19 stress was significantly related to anxiety ($\beta = 0.61$, $p < 0.001$), and online aggression ($\beta = 0.12$, $p < 0.001$). In addition, anxiety was significantly related to online aggression ($\beta = 0.48$, $p < 0.001$). The indirect effects of perceived COVID-19 stress on online aggression through anxiety were significant ($\beta = 0.33$, 95% $CI = [0.30, 0.36]$), which supported hypothesis 2. Furthermore, after adding anxiety to the regression equation in Model 3 compared to Model 1(see Table 2), perceived COVID-19 stress remained significantly associated with online aggression, indicating a partial mediating effect of anxiety.

3.3. Perceived anonymity as a moderator

The results of the moderation effects of perceived anonymity were illustrated in Table 2. We adopted the Model 15 of the PROCESS macro to test the moderation effect of perceived anonymity between perceived COVID-19 stress and online aggression. Results illustrated that the interaction between perceived COVID-19 stress and perceived anonymity was significantly related to online aggression ($\beta = 0.05$, $p < 0.001$, 95% $CI = [0.02, 0.07]$). The interaction between anxiety and perceived anonymity was significantly related to online aggression ($\beta = 0.13$, $p < 0.001$, 95% $CI = [0.11, 0.17]$). Thus, perceived anonymity moderated the direct and indirect pathways of perceived COVID-19 stress on online aggression.

TABLE 1 Descriptive statistic and correlation coefficients.

Variables	M	SD	1	2	3	4
1. Perceived COVID-19 stress	6.07	4.98	1			
2. Anxiety	4.29	4.73	0.64**	1		
3. Online aggression	19.28	9.40	0.51**	0.69**	1	
4. Perceived anonymity	17.84	5.59	0.13**	0.18**	0.17**	1

$N = 3,609$, **$p < 0.001$.

TABLE 2 Testing mediation effects of perceived COVID-19 stress on online aggression.

Predictors	Model 1 (OA)		Model 2 (AN)		Model 3 (OA)		Model 5 (OA)	
	β (95% CI)	t	β (95% CI)	t	β (95% CI)	t	β (95% CI)	t
Gender	−0.63 (−0.68, −0.58)	35.22**	−0.48 (−0.53, −0.43)	−19.38**	−0.40 (−0.44, −0.36)	−18.46**	−0.40 (−0.44, −0.36)	−19.22**
PCS	0.41 (0.39, 0.44)	−26.46**	0.61 (0.59, 0.64)	50.16**	0.12 (0.10, 0.15)	9.12**	0.10 (0.07, 0.12)	7.56**
AN					0.48 (0.45, 0.50)	34.36**	0.39 (0.37, 0.42)	28.27**
PA							0.07 (0.05, 0.09)	6.89**
PCS × PA							0.05 (0.02,0.07)	3.84**
AN × PA							0.13 (0.11, 0.17)	10.47**
R^2	0.47		0.38		0.53		0.58	
F	1576.11**		1090.05**		1357.96**		813.66**	

$N = 3,609$, **$p < 0.001$; PCS, Perceived COVID-19 stress; AN, Anxiety; OA, Online Aggression; PA, Perceived Anonymity.

FIGURE 2
Interaction effect of perceived COVID-19 stress and perceived anonymity on online aggression.

FIGURE 3
Interaction effect of anxiety and perceived anonymity on online aggression.
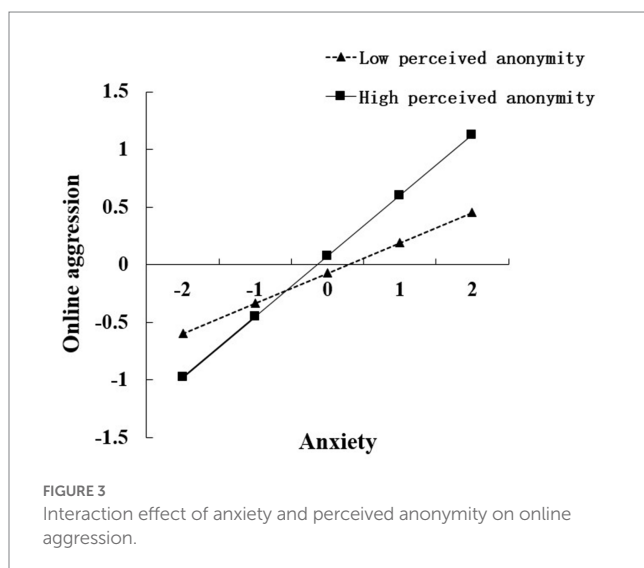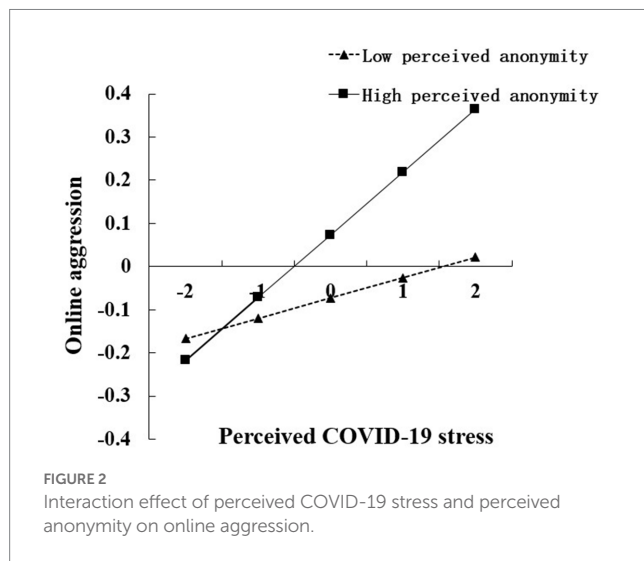
We conducted simple slope tests to visualize the interaction patterns. We plotted figures of perceived COVID-19 stress against online aggression (see Figure 2) and anxiety against online aggression (see Figure 3) under high and low (± 1 SD from the mean) levels of perceived anonymity, respectively. The results of simple slope tests suggested that perceived COVID-19 stress was significantly related to online aggression for college students with high perceived anonymity ($\beta_{\text{high PA}} = 0.14$, $p < 0.001$, 95% $CI = [0.11, 0.18]$, see Figure 2) and those with low perceived anonymity ($\beta_{\text{low PA}} = 0.05$, $p = 0.005 < 0.01$, 95% $CI = [0.02, 0.07]$, see Figure 2). However, compared to low perceived anonymity students, the effects of perceived COVID-19 stress on online aggression were stronger among high perceived anonymity students. In addition, the results of simple slope tests also suggested that anxiety was significantly positively related to online aggression for both college students with low and high perceived anonymity ($\beta_{\text{high PA}} = 0.52$, $p < 0.001$, 95% $CI = [0.49, 0.55]$; $\beta_{\text{low PA}} = 0.27$, $p < 0.001$, 95% $CI = [0.23, 0.31]$; see Figure 3). In other words, compared to college students with low perceived anonymity, those with high perceived anonymity would be more likely to be influenced by anxiety and to have more online aggression.

4. Discussion

The present study aims to discuss the effects of perceived COVID-19 stress on online aggression. The results found that perceived COVID-19 stress was positively significantly related to Chinese freshman college students' online aggression. This study further constructed a moderated mediation model to probe the mechanism of perceived COVID-19 stress on online aggression. The results showed that anxiety mediated the association between perceived COVID-19 stress and online aggression, and perceived anonymity was a moderator between the perceived COVID-19 stress and online aggression and between anxiety and online aggression.

4.1. Perceived COVID-19 stress and online aggression

No previous studies have discussed the relationship between perceived COVID-19 stress and online aggression among first-year college students; this study found that more perceived COVID-19 stress among first-year students may be associated with more online aggression, supporting hypothesis 1, which is consistent with the adult population [27] and international student populations [2]. Results from neurological studies also support that perceived stress is significantly associated with individuals' aggressive behavior [20]. The psychological changes involved in the shift to university are an important life transition, accompanied by changes in several important areas of life, including school, social life, and family life, where new students need to adapt to their new environment, establish new relationships, and learn to take personal responsibility [42].

During the COVID-19 epidemic, freshmen face not only the usual life changes but also interpersonal problems (the lock-down policies reduce peer interpersonal communication) and learning problems (difficulties with online learning and the transition from centralized to independent and intense learning) caused by the unstable epidemic [43]. Thus, freshmen face multiple stressors due to life transitions and stressors related to the epidemic.

The more stressors first-year students are exposed to, the more likely they are to use the Internet to solve or escape stress-related problems [23, 44], which also increases their risk of online aggression due to their enhanced access to the Internet [5]. The results of this study support Kowalski et al.'s [17] views on the use of the general aggression model to understand online aggression and validate that perceived COVID-19 stress is an important individual input variable influencing freshman online aggression.

4.2. The mediating role of anxiety

After examining the relationship between perceived COVID-19 stress and online aggression, this study further examined the mediating role of anxiety between the two variables. This study found that anxiety was an important mediator between perceived COVID-19 stress and individuals' online aggression, supporting research hypothesis 2. The results showed a significant positive relationship between perceived COVID-19 stress and anxiety, which is consistent with previous studies during epidemics [9, 43]. This study collected data during the recent new outbreak in China when some universities

were again shifting from offline to online teaching requiring social distance. As the unblocked status has been maintained for some time, first-year students are more likely to feel control loss and overloading on their lives (which is defined as perceived COVID-19 stress) and worries about the future when restrictions related to COVID-19 are enacted again, exacerbating the potential for mental health problems such as anxiety disorders (2). The many unconventional stressors linked to the epidemic may have primarily contributed to the large increase in anxiety disorders following the epidemic compared to the pre-epidemic period (28, 44).

In line with prior research (17, 45), the present study found a significant positive relationship between anxiety and online aggression. This could be explained by the potential increase in online aggression as anxiety may increase an individual's propensity to process negative information and have negative processing bias when interpreting ambiguous scenes and information, which often exist in cyberspace due to the absence of context like expressions, sounds (45, 46).

We examined the postulates of Kowalski et al.'s views on the use of the general aggression model to understand online aggression (17, 18) by exploring whether anxiety is an indirect cause of the effect between perceived COVID-19 stress and online aggression, and the results supported the model. Kowalski et al.'s views illustrate that input variables, including personal and situational factors, can influence individuals' online aggression through three direct pathways: cognitive, affective, and arousal (internal state) (17, 18). After considering the inputs and the internal state, individuals engage in an appraisal and decision-making process, ultimately choosing to act thoughtfully or impulsively. In contrast, anxious individuals tend to make impulsive decisions (47). This connection has been discussed in neurological research, which suggests that perceived stress and anxiety are risk factors for aggression, and they share to some extent the same cortical and subcortical anatomical underpinnings as aggression and that brain structures involved in anxiety symptoms also play a partially mediating role between these factors and aggression (20).

4.3. The moderating role of perceived anonymity

The present study further examined the moderating role of perceived anonymity in a mediated model of perceived COVID-19 stress, anxiety, and online aggression. The findings found a significant positive correlation between perceived anonymity and online aggression, consistent with previous research (36).

The results of the moderated effects analysis showed that perceived anonymity moderated the direct effect of perceived COVID-19 stress on online aggression; in particular, when the level of perceived COVID-19 stress increased, online aggression increased at a slower rate for students with low perceived anonymity, while online aggression of students with high perceived anonymity would increase at a faster rate with increasing perceived COVID-19 pressure. This implied that individuals with high perceived anonymity were more sensitive to growth in perceived COVID-19 stress compared to individuals with low perceived anonymity. Indeed, perceived anonymity moderated the effect of anxiety on online aggression. However, online aggression in both low and high perceived anonymity individuals rose with anxiety specifically, the rate of increment in the low perceived anonymity group was lower than in the high perceived

anonymity group. Both of these results support the theory of deindividuation (15) and confirm the contribution of anonymity. High levels of anonymity in online social media contexts are associated with higher levels of deindividuation. Individuals are more likely to engage in online aggression incidents when influenced by input factors and the "affect" of the internal state relevant to online aggression. Alternatively, online aggression perpetrators are less likely to fear revealing their actions, as with traditional aggression, due to screen barriers (48, 49).

5. Limitations and directions for future research

The present study still has the following limitations. Firstly, the cross-sectional study could not account for the causal relations between variables. Future studies could investigate causal inference using longitudinal or experimental design. Secondly, this study only tested a moderated mediation model with Chinese college students, and future studies could extend the findings to groups in other cultural contexts and make cross-cultural comparisons. Thirdly, the data collected in this study were during the epidemic, which may not be applicable to samples collected during non-epidemic periods. Future studies may consider validation during non-epidemic periods. Fourthly, in validating Kowalski et al.'s (17) view on the use of the general aggression model to understand online aggression, this study focuses on only one part of the internal state phase of the view proposed —— "affect" (e.g., anxiety). Future research may continue to test the applicability of Kowalski et al.'s views on online aggression and explore other theories that probably explain online aggression.

Despite these limitations, the present study also has theoretical and practical value. Theoretically, this study validates Kowalski et al.'s (17) views on the use of the general aggression model to understand online aggression and deindividuation theories through a mediating model of regulation and identifies a mediating role for anxiety and a moderating role for perceived anonymity, contributing to an understanding of the mechanisms underlying the relationship between perceived COVID-19 stress and cyberattack. Practically, this study shows that anxiety is a crucial variable mediating the relationship between perceived COVID-19 stress and online aggression, that immediate blocking and moderation of individual anxiety can help reduce their levels of online aggression, and that schools and communities can monitor students' stress and anxiety states and provide timely assessment and intervention. In addition, as the internet has become an essential social venue, schools and communities can provide online interventions and guidance on communication skills based on online platforms that are conducive to reducing students' stress and anxiety and leading to a more positive online social orientation.

6. Conclusion

Anxiety is an important mediator when exploring the potential mechanisms of perceived COVID-19 stress on online aggression among first-year university students in China. Future research is recommended to consider "anxiety" more comprehensively and to extend the validation study of Kowalski et al.'s (17) views on the use of the general aggression model to understand online aggression. Besides, perceived anonymity moderated the direct pathway

(perceived COVID-19 stress → online aggression) and indirect pathway (anxiety → online aggression) from perceived COVID-19 stress through anxiety to online aggression, suggesting that perceived anonymity is an important risk factor associated with the increase in online aggression. Future research may consider how to intervene in perceived anonymity and focus on clarifying the need for individuals to take responsibility for their own actions in cyberspace in order to minimize the level of perceived anonymity. Moreover, enhanced measures to alleviate stress and anxiety should be considered to lower online aggression, for example, by using online resources to assess and intervene with the degree of individuals' stress and anxiety to reduce online aggression.

Data availability statement

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

Ethics statement

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

Author contributions

LG, QY, and LX: conception and design of the study. QY: supervision and project administration. QY and LX: data collection. LG: data analysis. LG and LX: original manuscript. All authors contributed to the article and approved the submitted version.

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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A decline in perceived social status leads to post-traumatic stress disorder symptoms in adults half a year after the outbreak of the COVID-19 pandemic: consideration of the mediation effect of perceived vulnerability to disease

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Background/purpose: In December 2019, Wuhan, Hubei, China firstly reported the existence of the COVID-19 virus. It is crucial to prioritize the psychological well-being of citizens in lockdown cities and make more strides in the academic field of post-traumatic stress disorder (PTSD) to prepare for the post-pandemic era.

Methods: We took the cognitive-relational theory as our basis and collected Hubei province-level data (N=3,465) to examine the impact of perceived social status decline on the prevalence of PTSD symptoms, and checked the mediating effect of perceived vulnerability to disease (PVD) during the period of psychological adjustment.

Results: Using propensity score matching, we estimate the average treatment effect of perceived social status decline on PTSD level, and we robustly regress the two with weight adjustment generated in matching. We found that more decline in perceived social status is associated with a worse degree of PTSD symptoms, and confirmed PVD's buffering role although the mediating effect was not as high as hypothesized.

Conclusion and implications: Our study confirmed the decisive role of subject social status in health prediction compared to traditional socioeconomic measures, which extends the cognitive-relational in examining socioeconomic status and contributes to the dialog on socioeconomic inequality. We also suggested providing more social support at the community level and enhancing individuals' positive understanding to protect mental health.

KEYWORDS

COVID-19, perceived social status, post-traumatic stress disorder, perceived vulnerability to disease, Hubei China, propensity score matching

1. Introduction

A large amount of research evidence has revealed the prevalence of various psychological illnesses and related symptoms, including depression, anxiety, insomnia, and post-traumatic stress disorder (PTSD) since the outbreak of the COVID-19 pandemic (1–3). Since the COVID-19 pandemic, as a public health emergency, has negatively affected the life of whole people around the world, it is qualified as a traumatic event, exposure to which is the prior cause of the development of PTSD (4, 5). A higher combined prevalence of post-pandemic PTSD (~23%) than the estimated pooled prevalence after other disasters, such as major traumatic events (~20%) and floods (~16%), has been discovered, indicating that it is common for people who experienced an infectious disease outbreak to develop PTSD (3). Therefore, more research efforts should be made in the area of post-COVID-19 PTSD to assist in obtaining a thorough understanding of the detrimental impact of the pandemic.

Various COVID-19 studies have covered the negative effects of many pandemic-related traumatic experiences on PTSD and related responses. Research focuses can be concluded as follows: personal (i.e., sleep quality, experience or history of physical or psychological comorbidity), infectious-related factors (i.e., exposure, perceived vulnerability to disease), and societal factors [i.e., social isolation, stigmatization and discrimination, and social status decline; (3, 6)]. Among these factors, social status decline is one of the most important points that has attracted much attention from researchers. Large-scale pandemics have the potential to greatly increase global morbidity and mortality and cause profound disruptions in economic, societal, and political statuses (3). From the macro perspective, social distancing measures lead to the suspension of production and multiple working activities. For individual employees and their families, temporary layoffs of work during quarantine generate insecurity in employment and even financial loss when working part-time. Job changes that occur during quarantine put people under huge stress and financial strain, negatively impacting their quality of life and social standing (7). Those who are self-employed or are unable to work remotely while in quarantine may suffer more severe socioeconomic distress, which could affect how they perceive their social status. However, whether the perceived social status decline will influence the prevalence of PTSD or related traumatic stress symptoms has not been studied systematically.

Both cognitive-relational theory (8) and the cognitive model of PTSD (9) emphasize the importance of subjective appraisal of a traumatic event when assessing the psychological impact of a trauma or stress. When a threat is perceived to be more severe than it actually is, one may experience increased psychological stress that could develop into PTSD. Therefore, based on the theoretical background, we decided to explore the effect of perceived social status decline on developing PTSD symptoms. In addition, high perceived vulnerability to disease during an infectious disease outbreak can also contribute to the formation of PTSD by inducing traumatic stress responses (10). As the theory of fundamental social causes states, socioeconomic status (SES) is especially related to one's perceived control over life (11). Low SES is characterized by the perception that one's actions are persistently influenced by external forces that are beyond one's individual control and influence. When perceiving social status decreases during the pandemic, individuals' sense of control over life decreases

accordingly. When losing control over their life, individuals can feel vulnerable to the threat of infectious disease since they have limited resources to protect or support themselves through difficult times. Therefore, the mediating effect of perceived vulnerability to the disease on the relationship between perceived social status decline and PTSD symptoms deserves more extensive investigation.

Although the negative influences of the COVID-19 pandemic on the social and psychological well-being of Chinese, especially Hubei residents, had been investigated by some researchers at the beginning of the first outbreak, there has been little attention to study how—the detrimental consequences on the social aspect will influence PTSD symptoms under the traumatic public health crisis. Additionally, since PTSD is a psychological disorder that occurs in a period after a traumatic event, the study aiming to examine the PTSD level of Hubei residents needs to be conducted in the post-pandemic time. However, to our knowledge, none of the studies focusing on the COVID-19 pandemic had empirically investigated the PTSD level of Hubei residents in the post-pandemic era. Therefore, to fill these research gaps mentioned above and to improve understanding of the social and psychological consequences of infectious disease outbreaks, this study was conducted on the adult population of the Hubei province of China approximately half a year after the first COVID-19 outbreak to measure whether perceived social status decrease would cause the incidence of PTSD reactions in people and the mediating effect of perceived vulnerability to disease. The existing knowledge of PTSD and its related factors due to global infectious disease outbreaks will be discussed first, and then the findings of the current study will be presented.

2. Literature review

2.1. PTSD and infectious disease outbreaks

PTSD refers to a stress-related mental disease that affects persons who have encountered or experienced a life-threatening traumatic incident, placing considerable strain on individuals and society (12). Various chronic symptoms have been known to arise from the development of PTSD, such as intrusive memories and trauma re-experiencing through flashback-like dissociative reactions, the desire to avoid trauma-related thoughts, feelings, places, or people, emotional numbing or continuously negative cognition and mood, and hyperarousal, such as trouble sleeping, anxiety, and irritability (13, 14). Although not everyone who experiences traumatic stress will develop PTSD, it will be difficult for those who are diagnosed with persistent PTSD to recover completely or receive treatment. Failed recovery from PTSD can have long-term harmful effects on an individual's social function, family life, and personal health and may cause financial burdens (15).

Previous literature has discovered that the direct cause of PTSD is exposure to traumatic events (5, 16). As a public health emergency closely related to all people, COVID-19 has been confirmed as a qualified traumatic event that can lead to PTSD symptoms in the general population (4). Studies on the relationship between infectious disease outbreaks and people's mental health found that post-traumatic stress (PTS) is common in those who encounter infectious disease outbreaks [ex. SARS, Ebola, H1N1, etc.; (17)]. Therefore, due to the enormous detrimental consequences of PTSD on individuals

and their families, investigating the prevalence of PTSD or PTS symptoms in the post-pandemic period is of great importance in understanding the psychological burden on the public and possible identification and intervention strategies for reducing the negative effects of the trauma brought by the pandemic.

2.2. Risk factors for post-pandemic PTSD

Various studies have investigated the impact of the pandemic on individuals' mental well-being. Pandemic outbreaks that lead to worldwide detrimental consequences can be classified as traumatic events that could contribute to the development of PTSD (4). Pandemic-related stressful experiences, like quarantine, infection of self or family or friends, and potential financial loss, are all traumatic incidents that play as factors in the development of PTSD symptoms in individuals. According to existing studies, predicting risk factors for post-pandemic PTSD after infectious disease outbreaks can be classified into several aspects: personal, infectious-related, and social factors (3, 6).

The first personal factor that could lead to PTSD symptoms is sleep disruption. One of the serious health problems brought about by quarantine that could promote PTSD formation is irregular sleep schedules or even insomnia (3). With the suspension of school or business activities, people's regular schedules are disrupted, affecting the quantity and quality of their sleep (18). Poor sleep quality during quarantine has been shown to be a strong predictor and a vital characteristic of PTSD (14, 19). During the immediate aftermath of trauma, subjective sleep problems and interruption of REM sleep can indicate future PTSD development (14). Second, people with physical comorbidities have been proven to have a higher risk of developing PTSD (3). A study conducted after the SARS pandemic proved that the presence of chronic medical illnesses diagnosed before the onset of the pandemic and avascular necrosis were independent predictors of post-pandemic PTSD (20). At the same time, patients with comorbid diseases or psychiatric disorders were also found to be more susceptible to PTSD (3).

One of the other significant focuses of preexisting studies is infectious-related factors, including exposure to COVID-19 (both disease exposure and informational exposure) and perceived vulnerability to disease. In regards to exposure to disease, both previous studies on the SARS epidemic (16, 21) and recent research on the COVID-19 pandemic reveal the high rate of PTSD or PTS symptoms in frontline healthcare workers who have been constantly exposed to infectious disease patients in their workplaces (22–24). With the shortage of personal protective equipment plus the overloaded work intensity and often extended duration of shifts, frontline medical workers and health care providers continued to be exposed to extreme worry about personal safety and unavoidable emotional shock that is caused by the demise of infected patients (3). In addition, the level of exposure to pandemic-related information and news also contributes to the formation of PTSD or PTS reactions. When being bombarded with mass negative information regarding the pandemic, individuals' psychological conditions are more likely to be harmed drastically (3). The public, under a state of panic and worry due to the newly discovered virus, was more subjected to the influences of explosive fake news and posts regarding transmission mechanisms of the disease and infection-prevention techniques,

which could result in more stress and anxiety regarding the pandemic outbreak and increase the possibility of PTSD (25).

Furthermore, perceived vulnerability to disease or perceived risk of infection also has a positive relationship with the prevalence of PTSD symptoms (3, 26). Individuals who perceive themselves as highly likely to be infected may view this pandemic as more personally life-threatening and experience more traumatic stress than people who consider themselves less susceptible to COVID-19 (26).

Moreover, pandemic literature also strived to study social factors of PTSD, including social isolation and stigmatization, and discrimination. Social isolation is a major stressor activating psychological and physiological stress responses (27) and is an effective indicator of traumatic stress during life-threatening infectious disease outbreaks (28). Given the expanding COVID-19 crisis, policymakers in numerous nations hastily adopted social distancing and quarantine policies. Although quarantine effectively assists in controlling the spread of disease, confining individuals' freedom to go out or meet other people as usual increases the risk of mental illness and the prevalence of psychological distress symptoms (29). A meta-analysis conducted by Yuan et al. (3) concluded that the pooled prevalence of post-pandemic PTSD among pandemic victims who experienced quarantine during the outbreak (15%) was higher than that among victims without quarantine experience (5%). In addition, among people who experienced quarantine, as the length of confinement increases, the rate of stress in individuals increases accordingly (30). In addition, the experience of stigmatization and discrimination is another social factor that predicts post-pandemic PTSD in individuals. Many people claimed being discriminated against due to where they came from or lived during the disease outbreak or whether they had been infected or had close contact with confirmed cases (3).

2.3. Theoretical construction and hypothesis

2.3.1. Social status decline and PTSD

The traumatic experiences of declines in social status due to the pandemic, relevant financial loss and job instability as a result of quarantine created serious socioeconomic distress. It was a risk factor for symptoms of psychological disorders, including PTSD (31). Typically, social status is assessed through income, level of education, and employment (32). In addition to household income and educational attainment, employment is one of the other important objective and quantifiable indicators of individual social status in general (11). Employment not only indicates human capital but also has strong predictive validity in the material capital of individuals since it is typically closely related to the economic status of individuals. The COVID-19 pandemic has drastically affected socioeconomic development and work activities worldwide. Although the effects of COVID-19 on the economy at the macro and micro levels are still challenging to determine, the influences on the people and the families of those who lost their jobs, suffered temporary layoffs, or kept their jobs but faced the loss or worsening of their working situations have been analyzed by researchers (30). Nonetheless, apart from the impact of the objective decline in social status, how individuals perceive their changes in social status could have more detrimental effects on their psychological well-being.

2.3.2. Transactional model of stress and perceived social status decline

The transactional model of stress and coping (a.k.a. cognitive-relational theory) is a theoretical model that has been applied to understand the effects of stress in numerous studies (8). It was then adapted to explain PTSD by Kleber, Brom, and Defares (33). It played a fundamental role in developing an etiological model evaluating the influence of stress and coping strategies on psychological outcomes during stressful events. It is outstanding in that it focuses on the effect of individuals' cognitive assessment of trauma on their stress level, which indicates the impact of a significant interacting variable besides the traumatic event itself in forming PTSD (34). According to the transactional model of stress, subjective perceptions of threat may not always match the level of threat indicated by more objective measures and circumstances in life, and perceptions of threat may be more essential in determining levels of distress. Only when individuals perceive an event as stressful can it be such.

The transactional model of stress suggests the process of determining the importance of events for oneself (35). The primary appraisal includes assessments of events and interactions as threats or challenges or as being fundamental to oneself and entails determining the significance of a transaction for one's health. Threat appraisals considers the possibility of future harm or loss, both of which have detrimental effects. However, challenge appraisals focus on the positive interpretations of events and represent the expectation of progress or gain from experience. Individuals with high levels of negative affectivity were more likely to appraise events as threatening, while those with low levels of negative affectivity appraised them as a challenge (36, 37). In the context of global public health crises, such as the COVID-19 pandemic, various traumatic and stressful experiences, such as exposure to infection, social isolation, housing instability, and loss of control over social or financial status, all contribute to an increase in negative affectivity in public in general. Due to various uncertainties regarding transmission, treatment, and health impacts of COVID-19 at the beginning and the huge population density of China, which could speed up virus spread and medical system breakdown, Chinese people, especially Hubei residents, could be more anxious during the first outbreak comparing to people who lived in other countries that were affected later. Under these circumstances, it is highly possible that Hubei residents possessed an increased level of negative affectivity that led to threat appraisals. Therefore, with higher negative affectivity generated in the pandemic, individuals are more likely to appraise their job and financial instability as a solid threat. The results of studies have demonstrated a strong relationship between threat appraisal and coping strategies, which might further contribute to improper adaptation to stressful situations and increase psychological suffering (35).

Meanwhile, a growing amount of studies have shown that subjective ideas about one's social status are a better predictor of mental health outcomes than objective measures such as educational level, income, and occupation (38, 39). Job insecurity is defined as "the perceived threat of job loss and the worries related to that threat" (40). It is a subjective anticipatory perception, with worry and fears about the future of one's current job in the short or medium term (41). The current COVID-19 literature has revealed that the perceived risk of both employment and financial threat have negative effects on the physical, psychological, and psychosocial well-being of people (41). It

has been demonstrated that greater employment insecurity and job loss have been linked to greater depression symptoms since the start of the pandemic (7, 42). Additionally, individuals who believed that their work situation will worsen after the quarantine demonstrated higher perceived stress (30). It has also been shown (43) that workers perceive a loss of control in times of economic turbulence (such as significant crises and recessions, such as the one brought on by the COVID-19 pandemic), making the negative effects of job insecurity on mental health even worse (44). Nevertheless, few investigations have been conducted on the influence of subjective social status on PTSD.

Therefore, to solve the research puzzle of how the perception of a decrease in self-perceived social status influences PTSD symptom development, we established our first hypothesis:

> *Hypothesis 1:* A decline in perceived social status contributes to the prevalence of PTSD symptoms in people who lived in Hubei Province, China, during the outbreak of the COVID-19 pandemic at the beginning of 2020.

2.3.3. Perceived vulnerability to disease as a mediator in the relationship between perceived social status and PTSD symptoms

At the same time, previous studies have proven the effects of perceived vulnerability to the disease on the development of various mental health diseases and symptoms, including traumatic stress reactions, which could develop into chronic PTSD (10, 26). Perceived vulnerability to disease refers to the sense that it is easy for oneself to come into contact with infectious diseases and a feeling of aversion to viruses, which may result in an increase in multiple health protection behaviors. Although having a sense of vulnerability to coronavirus infection during the pandemic contributes to the adoption of more self-protective behaviors, individuals with a strong perception of vulnerability to COVID-19 may have a lower sense of control or safety, which further leads to anxiety and traumatic stress reactions (26). As claimed by the transactional model of stress (8), an individual's perception of threatening circumstances is more strongly linked to distress than the objective event itself. The COVID-19 pandemic has caused numerous infection cases and deaths since its outbreak, creating tremendous panic and worry in public regarding health and safety. Furthermore, with continual exposure to COVID-19-related news and stressful content through the media and other social networking sources, an increasing degree of COVID-19-related worries and distress has been found in the general population [e.g., (25, 45, 46)]. Consistent with the transactional model of stress, the cognitive model of PTSD (9) also suggests that psychological reactions to traumatic events might differ depending on how they are appraised (e.g., appraisals of danger lead to fear) and that the development of PTSD is more likely when individuals' appraisals generate a "sense of serious current threat" (p. 320). Given the high transmission rate and mortality of the COVID-19 pandemic, it is reasonable to assume that it has generated a widespread sense of vulnerability to disease (26). Furthermore, as supported by the theory of the fundamental social cause, perceiving oneself as having lower social status generates higher risk perceptions, leading to more perceived

FIGURE 1
Conceptual framework.
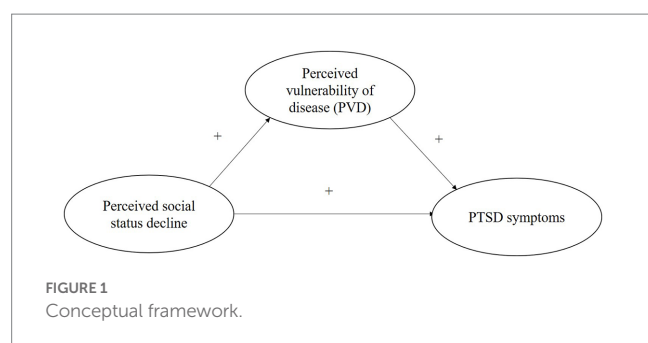
vulnerability to disease (11). Considering the constant worries about personal and family health plus the insecurity in employability and related decline in social status, individuals with a higher perception of vulnerability to disease could encounter higher risks of developing PTSD or stress-related symptoms. Therefore, in this study, we also propose the following hypothesis:

> *Hypothesis 2:* Perceived vulnerability to disease mediates the positive effects of a decline in perceived social status on the development of PTSD symptoms in people who were in Hubei during the first outbreak of the pandemic in 2020 (Figure 1).

2.4. The current study

As the region in which the coronavirus was first discovered in 2019, Wuhan and the whole Hubei Province of China could be considered the most severely affected regions worldwide at the beginning of the pandemic. In Hubei Province, where the data of this study were collected, social distancing measures and quarantine policies were adopted from January 23 to April 8, 2020, in most parts of the province. An immense number of employees had their employment contracts temporarily terminated or suspended due to the large-scale suspension and closure of numerous industrial activities for two and a half months (26). Furthermore, the instability of the infection rate and anti-pandemic measures caused additional uncertainty for workers regarding their employment security, which is closely related to their perception of social status. To investigate the potential detrimental consequences of these experiences, the study gathered data from Hubei 2 months after the release from confinement. For our method, we tried to control confounding variables via the counterfactual framework of propensity score matching, which is widely used to overcome the shortage of cross-sectional data in the fields of epidemiology, health services research, economics, and social sciences (47). This study had two major aims: first, to analyze the relationship between perceived social status decline and the prevalence of PTSD symptoms in the adult population in Hubei. Second, we investigated the potential mediating effect of perceived vulnerability to disease on the relationship between the two variables mentioned before. Therefore, our goal was to conduct an initial analysis of how subjective socioeconomic factors can influence people's psychological well-being in the context of a prolonged public health emergency in the region where the pandemic originated.

3. Methods

3.1. Sampling

As the cities where the coronavirus outbreak began, Wuhan and other cities in Hubei Province were locked down from January 23 to April 8. The present work is based on an original study conducted in Hubei in June 2020—the crucial period of psychological adjustment for residents—by the School of Sociology, Central China Normal University in China. Out of the infection risk and prevention requirements, data were collected by an online questionnaire during the lockdown time, including several modules on mental health, family relationships, and social interaction. In the thematic modules involved in this study, a total of 3,465 valid participants aged above 16 responded to it. The sample comprised 52.90% males; the average age was 31.81 years; and 26.93% lived in Wuhan City. The research received ethical approval from the School of Sociology ethics committee at Central China Normal University in China.

We distributed electronic questionnaires through the trade union platform of Hubei, targeting a total of 14 million workers (including migrant workers) across the entire province. To reduce sampling bias, we initially focused the survey on workers aged 16 and above residing in county-level or higher cities within Hubei province. We implemented a filtering prompt in the first question of the questionnaire. Additionally, we provided a 100% chance of monetary incentive to encourage widespread survey sharing. We excluded samples with response of less than 5 min and samples that exhibited logical inconsistencies. Furthermore, we employed measures such as IP address identification and restrictions on accounts to minimize duplicate submissions. Lastly, to obtain a representative sample, we appropriately weighted the data using population statistics provided by the Hubei Provincial Federation of Trade Unions.

3.2. Measurement

3.2.1. PTSD level

The dependent variable was the PTSD level. It was measured by The Impact of Event Scale–Revised (IES-R), which is based on three clusters of symptoms identified in the *Diagnostic and Statistical Manual of Mental Disorders*, to assess subjective distress caused by traumatic events. Participants were asked to rate their distress status from never (score 0) to all the time (score 4) with 22 items. In addition to the mean PTSD level applied in the models, we also report dichotomous data in Appendix I according to the cutoff of 1.5 suggested by Creamer et al. (48). The overall Cronbach's coefficient of the scale was 0.980.

3.2.2. Perceived social status decreases

The independent variable was perceived social status decrease. The participants were asked to what extent COVID-19 inflected their social status in the survey. We based the response and classified the participants into two mutually exclusive types: the decrease group (coded as 1) and the control group (perceived social status increased or remained the same, coded as 0).

3.2.3. Mediator

In addition, we used the perceived vulnerability to disease as our mediator, which was measured by The Perceived Vulnerability to Disease Questionnaire (49). It is a widely used 15-item seven-point scale, ranging from strongly disagree (1) to strongly agree (5). It assesses one's beliefs about personal susceptibility to and emotional discomfort associated with a potential contagion from infectious diseases. To enhance the cross-cultural adaptability, we deleted the fourth item ("I do not like to write with a pencil someone else has obviously chewed on.") and kept 14 items. The goodness of fit test showed that the population follows the distribution [$\chi^2(58) = 2012.008$, $SRMR = 0.12$, $CFI = 0.94$, $TLI = 0.91$, $RMSEA = 0.09$]. The overall Cronbach's coefficient of the scale was 0.930.

3.2.4. Covariates

Based on the literature review, we found potentially available explanatory factors for PTSD perception. We included personal factors, infectious-related factors, and social factors, which are presented in Table 1.

3.3. Analytical strategy

We followed a two-step analytical strategy to empirically examine the association between the decrease group and the control group. In the first step, we performed a propensity score analysis to control for potential selection bias. We used a developed package—teffects psmatch—available in Stata 17.0 to estimate the average treatment effect on the treated (ATET). We adopted a 1:1 matching strategy with replacement, estimated the p score by a logit model, and set the default caliper. Only the sample in common support was matched. In the second step, we estimated an ordinary least-squares linear regression model and multiple linear regression using social status decrease as the key response. The goal is to understand the different effects of whether social status decreased or not on the probability of PTSD levels among citizens after adjusting for a set of 18 covariables. Model 1 was our baseline model. Based on Model 1, Model 2 added demographic covariates, and Model 3 added all covariates. The matched columns show the compared result of estimates after applying sample weight depending on the number of matching times generated

TABLE 1 Covariate meanings and measurements.

Covariates	Meanings and measurements
Personal factors	
Age	Age as of 2022.
Gender	Male and female.
Education	The number of years of education a person completed.
Party	Whether one was a Party member.
Household registration	It was categorized into four level (countryside, town, rural–urban fringe, and urban areas) depending on the distance to city center.
Job status	Job status in the last 3 months.
Income	The average monthly income of family since 2020 (16 grades).
Sleep health	The product of sleep time (hours) and sleep quality, and sleep quality was rated by participants from very bad (1) to very good (4).
Infectious-related factors	
Perceived income decrease	The extent of COVID-19 inflected on family income.
Critical negative events	Whether one had COVID-19 cases (close-contact cases, suspected cases, confirmed cases, or death cases) in the family.
Exposure to epidemic information	The average amount of time participants had spent searching and reading epidemic information since the lockdown.
Social factors	
Interpersonal relationship (with family)	The frequency of quarrel with child/spouse during the pandemic, from no at all (1) to very frequent (3).
Interpersonal relationship (with epidemic prevention personnel)	Whether one had conflicts with epidemic prevention personnel.
Strictness of lockdown (subject)	Subjective feeling to lockdown policy, from no at all (1) to very strict (5).
Strictness of lockdown (object)	Objective frequency of going out, from no at all (1) to very frequent (5).
Encounter of Hubei citizens	The number of following things participants have encountered: (a) See comments on the internet or in chat groups that discriminate against or curse Hubei/Wuhan citizens; (b) Be refused to accept by local government and communities when returning hometown during the Spring Festival; (c) Be excluded when travelling, such as not allowed to stay at hotels; (d) Be ostracized and attacked by relatives and neighbors when returning hometown during the Spring Festival; (e) Be rejected by boss because of being Wuhan/Hubei citizens when returning to work; and (f) Be shunned and ostracized by colleagues because of being Wuhan/Hubei citizens after returning to work.
Fixed: city	A categorical variable, including Wuhan city, other cities in Hubei province, Hubei/Anhui/Henan provinces near Hubei, other provinces in China.

during matching. Finally, we checked the possibility of PVD as a mediator of the model.

4. Result

4.1. Descriptive statistics

Descriptive statistics are presented in Appendix I to summarize the sample's characteristics and examine the variables' distributions. Overall, 21.53% of participants' social status decreased during the lockdown, whereas 78.47% increased or remained the same. The average PVD level was approximately 2.95. Nearly one-quarter of the sample had PTSD symptoms; the average education year was 13.95 years; 25.63% were Party members; 26.93% were Wuhan citizens in our sample, while 51.66% lived in the countryside far away from the city center; and 6.84% did not have jobs in the 3 months before our survey. Only 5.97% of respondents did not have conflicts with epidemic protection personnel; almost half of them thought the lockdown policy was stringent, and 64.76% did not have the opportunity to leave their homes. A total of 6.84% had COVID-19 cases in their family. On average, our respondents spent 2.52 h searching or reading COVID-19 information; each citizen encountered 1.4 negative incidents.

We also compared the characteristics between the treatment group (decrease group) and the control group. The mean PTSD level in the treatment group was significantly higher than the control group, both before and after matching. Before matching, the likelihood of being in the decrease group was greater for participants who were non-Party members, living in urban areas, with perceived income decreases and frequent quarreling with families compared with those in the control group. The likelihood of being in the decrease group was smaller for participants who lived in the countryside, had no COVID-19 cases in their families, and lived in Wuhan than for those in the control group. On average, participants in the control group had lower PTSD levels and healthier sleep and encountered fewer negative things in life. Before matching, the likelihood of being in the decrease group was greater for participants who were male, non-Party members, living in the countryside, perceiving an income decline, having a worse relationship with family and epidemic protection personnel, feeling that the lockdown policy was strict, having worse sleep health (below average), living in other cities in Hubei, above average reading of epidemic information, and encountering more negative things in life compared with those in the control group.

4.2. Multivariate results

Before estimating ATET, we checked the quality of PSM. We conducted paired t-tests with the propensity-score-matched groups. The results showed that the difference between groups was insignificant after matching and excluding the treatment variable (see the compared *p* value in Appendix I). We also found that the normalized bias of most variables in the matched groups was less than 10%, and most *t*-tests did not reject the null hypothesis that there was no systematic difference between the treatment group and the control group (Table 2). In addition, only 26 observations are off common support, which means we lost a few samples during matching. Figure 2

shows the comparison of the kernel density estimate between the treatment group and the control group, directly showing the good quality of matching.

Table 3 provides the results of the matching. The level of PTSD in the treatment group was 0.266 higher than that in the control group on average, which means that a social status decrease could increase the PTSD level by 0.266 on average ($p = 0.000$, SD = 0.053).

We tested for homoscedasticity with the Breusch-Pagan/Cook–Weisberg test, which indicated OLS robust estimations in all cases except matched Model 3 (matched) in order to control for heteroskedasticity. We checked potential multicollinearity issues by computing the Variance Inflation Factor (VIF). Results for mean VIF range between 1.00 and 1.17, and all individual VIFs are well below 1.5. This is far below values that would suggest any multicollinearity issue being relevant. To account of potential correlation across observations for districts within the same cooperative arrangement, we cluster our estimations by city unit. The Durbin–Watson statistics of our models indicate no autocorrelation problems in unmatched models. After introducing propensity score weighting, matched models unavoidably exhibit a certain degree of autocorrelation. The Shapiro–Wilk test showed that some variables were not distributed normally. Therefore, we used the robust regression method to test the structural models.

Table 4 presents estimates of the average effect of social status decrease on PTSD levels (standard errors in parentheses) with different specifications. Model 1 and Model 2 seemed unable to support our hypothesis among the matched sample. The results seem relatively robust, with positive coefficient estimates, which remain significant after adding all covariates (Model 3, $\beta_{matched} = 0.185^{***}$, $R^2 = 0.259$). The models suggest that a greater decrease in social status is correlated with a worse degree of PTSD symptoms. Meanwhile, the results also show that the higher income group, people susceptible to disease, people quarreling frequently, and people with more negative encounters reported higher PTSD levels. In contrast, sleep quality was significantly negatively correlated with PTSD after adjustment.

4.3. Mediating effect

Given the relatively higher performance of PVD in Model 3 ($\beta_{matched} = 1.014^{***}$, SD = 0.00973) and the theoretical basis, we checked the possibility of PVD as a mediator of the model. We used bootstrapping via Stata 17.0 to test for potential mediating effects. We adopted the recommended 95% confidence intervals (the bias-corrected percentile method) and used 2,000 bootstrap samples (50). Table 5 shows that PVD acted as a partial mediator, buffering the effects of social status decrease on PTSD levels. The indirect effect (0.039^{***}) and the direct effect (0.207^{***}) were statistically significant. Thus, Hypothesis 2 was supported.

5. Discussion

The main goal of our study was to examine an initial analysis of how socioeconomic factors can influence people's psychological well-being in the context of a prolonged public health emergency in the region where the pandemic originated. Thus, we analyze the relationship between perceived social status and the prevalence of

TABLE 2 Balancing hypothesis test showing the variables' characteristics before and after matching.

Variables	Unmatched	Mean		Bias (%)	*t*-Value	*p*-Value
	Matched	Treated group	Control group			
Gender	U	0.550	0.523	5.3	1.27	0.203
	M	0.551	0.561	−2.2	−0.42	0.676
Age	U	31.582	31.870	−3.1	−0.74	0.458
	M	31.509	31.698	−2	−0.4	0.692
Education	U	13.588	14.047	−15.7	−3.87	0.000
	M	13.588	13.571	0.6	0.12	0.907
Party	U	0.232	0.263	−7.2	−1.72	0.085
	M	0.231	0.221	2.2	0.43	0.664
Household registration	U	2.865	3.091	−19.1	−4.72	0.000
	M	2.872	2.848	2.1	0.39	0.699
Job status	U	0.914	0.914	0.2	0.05	0.956
	M	0.914	0.927	−4.8	−0.96	0.338
Income	U	4.400	5.271	−31.6	−7.25	0.000
	M	4.408	4.377	1.1	0.25	0.804
Perceived income decline	U	0.851	0.551	69.5	15.45	0.000
	M	0.850	0.848	0.6	0.14	0.885
PVD	U	2.981	2.936	13.7	3.32	0.001
	M	2.975	2.983	−2.5	−0.49	0.628
Quarrel with family	U	1.814	1.644	23.9	5.95	0.000
	M	1.807	1.757	7	1.33	0.182
Conflict with personnel	U	0.932	0.943	−4.5	−1.12	0.262
	M	0.935	0.930	2.2	0.41	0.679
COVID-19 cases	U	0.075	0.067	3.3	0.81	0.415
	M	0.073	0.067	2.1	0.41	0.684
Strictness of lockdown policy	U	4.245	4.348	−10.6	−2.66	0.008
	M	4.246	4.250	−0.4	−0.08	0.937
Frequency of going out	U	1.414	1.449	−5.2	−1.23	0.218
	M	1.413	1.432	−2.8	−0.55	0.58
City	U	1.310	1.265	4.1	0.99	0.325
	M	1.313	1.216	8.9	1.74	0.082
Sleep health	U	19.862	21.609	−21.6	−5.28	0.000
	M	19.918	19.980	−0.8	−0.15	0.882
Epidemic information	U	2.580	2.500	4.6	1.12	0.263
	M	2.563	2.621	−3.3	−0.65	0.519
Encounters	U	1.635	1.330	20.5	5.01	0.000
	M	1.614	1.646	−2.2	−0.4	0.687

U, unmatched; M, matched.

PTSD symptoms mediated by perceived vulnerability to disease in the adult population in Hubei Province. We conducted an online questionnaire survey (*N* = 3,285) in Wuhan in June 2020 using multiple linear regression and propensity score matching analysis strategy. The study found that a decrease in perceived social status would lead to an increase in their PTSD levels compared to people with a constant perceived social status, and each decrease in the perceived unit of social status increases the level of PTSD by approximately 0.1 to 0.4 units. Perceived vulnerability to disease plays a partial mediating role in the positive relationship between perceived social status decline and an increase in PTSD. Although the indirect effect (0.039***) and the direct effect (0.207***) were statistically significant, we failed to capture the solid mediating effect of perceived vulnerability to disease.
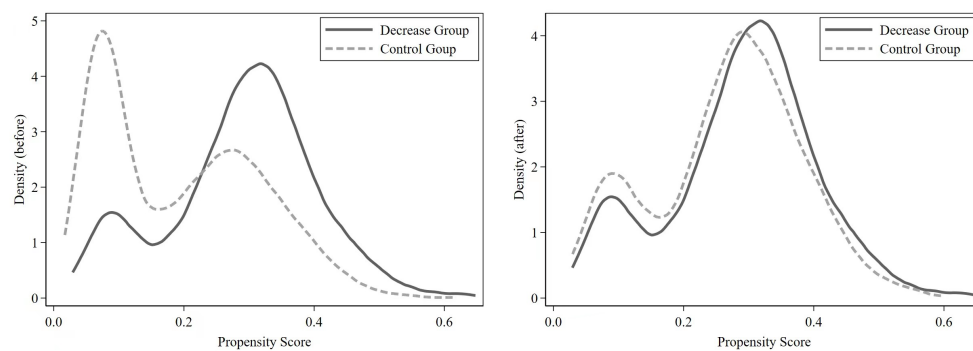
FIGURE 2
Kernel density estimate before and after matching.

TABLE 3 Average treatment effect of social status decline on PTSD level.

	Coefficient	AI robust std. err.	z	P > z	[95% confidence interval]	
ATET	0.226	0.053	4.22	0.000	0.121	0.330

5.1. The decisive role of perceived social status in mental health prediction

It is worth mentioning that the present research departs from those studies that focus on objective conditions. In the context of the COVID-19 pandemic, the decline in socioeconomic status is seen as a threat. The widespread use of social isolation policies, a decline in economic income, and occupational instability have all brought about negative mental and physical outcomes (31). However, existing studies have overlooked that perceived threats are a more direct factor causing PTSD compared to objective conditions. There is evidence to suggest that the relationship between subjective social status and mental health complies with the same reverse gradient found using objective social status indicators (51). We controlled for the variables closest to SES indicators (education, income, perceived income) and still obtained evidence of the positive impact of perceived social status decline on PTSD. This suggests that subjective social status may reflect unique aspects of socioeconomic status and may be more powerful in determining certain health outcomes than traditional SES measures.

In addition, in terms of the decisive prediction of subjective social status on mental health, the present finding is reasonable and consistent with previous research. Specifically, the conclusion further confirms the decisive role of subjective social status in health prediction (39). Compared with objective socioeconomic status, subjective socioeconomic status perception has a stronger effect on people's well-being (19). Alcover et al. (41) found in a survey of adults in Chile from March to April 2020 that job insecurity and financial threats are associated with a decline in people's general mental health. Especially in countries with collectivist cultures, people perceive socioeconomic status through social relations and social support, which has a more direct predictive effect on their mental health (52). The current conclusion is also closely related to the cognitive model

of PTSD (9), in which the negative evaluation and memory of traumatic events have an impact on sustained PTSD. After a stressful event occurs, the focus is not on the event itself but on the negative evaluation of and sense of threat from the event. The cognitive model of PTSD (9) emphasizes the importance of subjective appraisal of a traumatic event when assessing the psychological impact of a trauma or stress. Subjective perceptions of a threat do not necessarily match the degree of threat indicated by more objective criteria and living conditions, and perceptions of threat are in fact more important in determining levels of distress.

5.2. Loss of indicator sensitivity of perceived vulnerability to disease for predicting PTSD

In terms of unexpected results, surprisingly, we found weak evidence for the mediating effects of perceived vulnerability to disease. Hypothesis 2 predicted that perceived vulnerability to disease mediates the positive relationship between a perceived decline in social status and PTSD. As shown in Table 5, perceived vulnerability to disease acted as a partial mediator, buffering the effects of perceived social status decrease on the level of PTSD symptoms. The indirect effect (0.039***) and the direct effect (0.207***) were statistically significant. Although Hypothesis 2 was supported, we failed to capture the strong mediating effect of perceived vulnerability to disease. Previous studies have proven the effects of perceived vulnerability to the disease on the development of various mental health diseases and symptoms, including traumatic stress reactions, which could develop into chronic PTSD (26). However, when comparing our results to those of older studies, it must be pointed out that the decisive role of subjective social status in mental health prediction may be the reason for this deviation, and the specific explanation is as follows.

First, this may be due to the high threat of COVID-19 to the maintenance of self-status, leading to the loss of indicator sensitivity of perceived vulnerability to disease for predicting PTSD. At the beginning of the COVID-19 pandemic, although people's objective socioeconomic status has not changed, their feelings may not be the same. The impact of a decline in perceived social status on mental health typically occurs in elderly individuals, ethnic minorities, and immigrant groups (52–55). Green's (52) study showed that compared

TABLE 4 Effect of social status decline on PTSD level.

	Model 1		Model 2		Model 3	
	Unmatched	Matched	Unmatched	Matched	Unmatched	Matched
Social status decline	0.338*** (0.0371)	0.0631 (0.0539)	0.314*** (0.0358)	0.0587 (0.0570)	0.208*** (0.0256)	0.185** (0.0477)
Gender			−0.0159 (0.0399)	0.0827 (0.0816)	0.0173 (0.0263)	0.100 (0.0591)
Age			0.00218 (0.00193)	−0.000139 (0.00233)	0.000863 (0.00200)	0.00184 (0.00152)
Education			0.00271 (0.00969)	−0.0200 (0.0123)	0.00544 (0.00821)	−0.0128* (0.00523)
Party			0.0410 (0.0484)	0.0428 (0.0473)	−0.00479 (0.0340)	−0.0516 (0.0694)
Household registration			0.0523** (0.0126)	0.0611 (0.0386)	0.0266* (0.00902)	0.0461 (0.0263)
Job status			0.0785 (0.0492)	−0.0733 (0.0600)	0.0137 (0.0715)	−0.0951** (0.0242)
Income			0.0142 (0.00779)	0.0508* (0.0208)	0.0208** (0.00632)	0.0527** (0.00973)
Perceived income decline			0.172*** (0.0213)	0.212 (0.119)	0.0943** (0.0234)	0.209 (0.0991)
PVD					0.846*** (0.0534)	1.014*** (0.0953)
Quarrel with family					0.0945** (0.0257)	0.151*** (0.00762)
Conflict with personnel					−0.0949 (0.106)	0.109 (0.147)
COVID-19 cases					0.442*** (0.0341)	0.124 (0.167)
Strictness of lockdown policy					−0.00567 (0.0216)	−0.0236 (0.0737)
Frequency of going out					0.0124 (0.0255)	−0.00590 (0.0997)
Sleep health					−0.0213*** (0.00134)	−0.0163* (0.00516)
Epidemic information					0.0229** (0.00541)	0.0291 (0.0324)
Encounters					0.0983*** (0.00713)	0.139*** (0.0175)
_cons	0.839*** (0.0608)	0.951*** (0.0813)	0.325** (0.0701)	0.663* (0.254)	−1.829*** (0.269)	−2.698*** (0.355)
VIF	1.00	1.00	1.13	1.14	1.12	1.17
B-P/C-W Test p	0.012**	0.069*	0.039**	0.281	0.000***	0.000***
Durbin–Watson	1.889	0.706	1.898	0.695	1.940	0.717
N	3,465	3,439	3,465	3,439	3,465	3,439
R^2	0.022	0.001	0.037	0.041	0.232	0.259

Robust standard error are clustered at city level. Standard errors in parentheses. *$p < 0.1$, **$p < 0.05$, ***$p < 0.01$.

to Hispanic immigrants who have immigrated to the United States for less than 3 years, immigrants who have resided in the US for more than 3 years have higher economic income, but their physical and mental health levels are worse. This is because the late-arriving group has never experienced a decline in socioeconomic status in their original residence. However, when they came to the United States, the perceived pressure of socioeconomic status decline led to their physical health level decline. Puerto Rican ethnic minority groups have also shown negative effects of reduced perceived social status on mental health (53). Research on the mental health of elderly people directly suggests a correlation between their perceived decline in social status and social acceptance (54, 55). Although our survey

controlled for age, income, education level, and perceived income level, consistent results were obtained. In stress crisis events, adults experience a decrease in perceived social status, leading to an increase in their PTSD levels.

Furthermore, discrimination and stigmatization have a more direct impact on their mental health than perceived vulnerability to disease. The common view is that the outbreak of pandemic diseases may also have given rise to stigmatizing factors such as fear of isolation, racism, discrimination, and marginalization with all its social and economic ramifications (56). After strict quarantine policies, the number of infections reported every day gradually decreased after reaching its peak until it clears, and people believe that

TABLE 5 Mediating effect of PVD.

	Point estimate	Product of coefficient		Bootstrap 2,000 times, 95% CI (Bias-corrected percentile method)		
		SE	z	Lower	Upper	p value
Direct effect	0.207	0.036	5.72	0.134	0.276	0.000
Indirect effect	0.039	0.012	3.32	0.017	0.061	0.001

the actual infection range is controllable and traceable. Compared to the damage and harm caused by infectious diseases, the impact of discrimination experienced and heard by people had not disappeared since the release from quarantine (April 8, 2020) until the time of our investigation (June 2020). It is worth noting that the outbreak of the pandemic occurred during the Chinese New Year, and the 40-day "Spring Festival Movement" is an annual peak period of population mobility. Even if it was affected by the pandemic, the flow of 1.480 billion people is still a remarkable number (57). In view of the high transmission rate and high mortality rate of the COVID-19 pandemic, it is reasonable to believe that it has generated a wide range of disease susceptibilities (26), and mobility has exacerbated people's panic. People who are considered to be at high risk of infection will suffer discrimination and stigmatization (31). Many people reported being discriminated against because of where they come from or currently lived during the panel outlet or whether they have been infected or have had close contact with confirmed cases (3). This has formed a tense and unacceptable atmosphere, bringing a sense of threat to the decline of their socioeconomic status, which is more urgent.

Finally, the perceived decline in social status at the beginning of the pandemic can directly predict perceived vulnerability to disease. When perceived job instability is assessed as a threat, the sense of stress, risk perception, and loss of control will increase, which will lead to enhanced perceived vulnerability to disease (26). Perceived vulnerability to the disease itself is caused by the perceived threat of social status decline. Therefore, regardless of whether it is mediated by perceived vulnerability to disease, PTSD is ultimately caused by the perceived threat of social status decline. Perceived vulnerability to disease partially mediates the relationship between perceived social status decline and the prevalence of PTSD symptoms, but the utility is not significant. This further confirms the decisive role of subjective social status in mental health prediction.

5.3. Practical implications

We contribute to the dialog on socioeconomic inequality by clarifying how perceived social status affects the prevalence of PTSD symptoms in the early days of the COVID-19 outbreak. Based on cognitive-relational theory, research has mainly been conducted from the perspective of perceptual evaluation. Our research extends this theory to the examination of socioeconomic status.

Furthermore, our findings have several practical implications. The conclusion reminds us that for individuals, a positive understanding

of sudden crisis events can serve as a long-term resource to protect their mental health. Many studies have mentioned the positive role of supporting networks or resources in protecting individual mental health (11) and people's sense of threat to events such as job instability, declining economic income, and loss of professional reputation (31, 41), which is the fundamental cause of PTSD. This reminds us that when public crisis events erupt, policymakers and social service providers need to apply event response techniques when intervening with individuals, starting from the trauma victim's understanding of the event to solving the problem, and treating their PTSD or other mental trauma may be effective. During the pandemic, various interventions can be incorporated into positive psychological factors, including but not limited to helping people find a sense of meaning and coherence and utilizing self-compassion, gratitude, hope, and other personality strengths to cultivate positive and optimistic emotions (58).

More importantly, given the significant impact of perceived social status on the prevalence of PTSD symptoms in individuals, it is necessary to increase social support. There is established evidence that higher levels of social support predict higher perceived social status (52). It should be emphasized that intervention at the community level is more effective than intervention at the individual level, especially when people perceive themselves as belonging to a minority group (53). During the spread of the pandemic, at the community level, positive feedback from community workers and social service providers to residents who encounter difficulties is beneficial for protecting their perceived social status, which is effective and necessary. Specific measures can increase support for psychological counseling for community residents, as well as provide sufficient supply when they encounter social isolation, with special attention to forming support in relationships and social interactions. Given the high transmission rate of the pandemic, online network support is also a more suitable and convenient method. Through online technology, people's social interactions are reconnected, which has been proven to have practical effects.

Especially, protection can be implemented through public policies to reduce people's sense of discrimination and stigmatization. During the outbreak of the epidemic, quarantine is a common control measure. However, the widespread use of isolation of quarantine has brought widespread panic, acute stress disorder, anxiety, insomnia, and other adverse psychological symptoms (31). The author has personally experienced 14 days of strict centralized isolation, and suggested that the following key actions could be effective: first, maintain transparency of information, from the preparation before isolation to the action under surveillance during isolation, and during the period of home isolation after isolation, the government executives need to maintain full communication with relevant parties. The second is to ensure sufficient supply, basic water, food, and epidemic prevention supplies should be available at all times, and comfortable accommodation should be provided as much as possible to alleviate anxiety. The third is to establish a virtual support network, such as establishing centralized online communication groups for isolated populations and providing virtual space for mutual support. The fourth is to actively disseminate scientific epidemic prevention knowledge and protective information in news and public media, in order to alleviate discrimination against individuals under quarantine and residents in epidemic areas.

5.4. Limitations and future research

Taken together, our studies provide some compelling initial evidence for the significance of perceived social status for PTSD symptoms; however, further work is needed in several areas. First, this study was conducted in the early stages of the COVID-19 pandemic (June 2020), and its applicability to outbreaks is limited to the early stages. It is possible that the perceived social status response is caused by stress, and whether it has a long-term effect on PTSD as the pandemic eases and gradually disappears has not received attention. Second, the sample selection is based on the province where the pandemic broke out (Hubei Province, China), rather than the data collected nationwide. Our data was collected through an online questionnaire based on a trade union platform, which lacks representativeness compared to random sampling. However, we took various measures to reduce sampling bias. Our sample did not include an adequate number of confirmed COVID-19 cases as participants, and the research results should be interpreted with caution when applying them to confirmed cases. In addition, PSM relies on observational selection and cannot completely solve more general endogenous problems such as self-selection and missing variables. However, it constructs a counterfactual framework by reducing dependence on functional form settings. Weight adjustment generated in matching was also used to reduce bias as much as possible. Finally, our control variables did not consider the fluctuations in the market financial environment or the political conflicts and dynamics in the early stages of the epidemic. These variables are difficult to capture, and the impact of these variable relationships is unknown. Further research is suggested to be carried out among young people and elderly individuals in epidemic areas to observe the perceived long-term impact of socioeconomic status on the mental health of more vulnerable people.

Data availability statement

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

Ethics statement

The studies involving human participants were reviewed and approved by Institutional Review Board of Central China Normal University. The patients/participants provided their written informed consent to participate in this study.

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Author contributions

YW contributed to conception and design of the study. YW organized the database. SX performed the statistical analysis. YC, SX, and HL wrote sections of the manuscript. All authors contributed to the article and approved the submitted version.

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Conflict of interest

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

Publisher's note

Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyt.2023.1217264/full#supplementary-material

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A multifactorial framework of psychobehavioral determinants of coping behaviors: an online survey at the early stage of the COVID-19 pandemic

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Coronavirus disease 2019 dramatically changed people's behavior because of the need to adhere to infection prevention and to overcome general adversity resulting from the implementation of infection prevention measures. However, coping behavior has not been fully distinguished from risk perception, and a comprehensive picture of demographic, risk-perception, and psychobehavioral factors that influence the major coping-behavior factors remain to be elucidated. In this study, we recruited 2,885 Japanese participants. Major coping-behavior and risk-perception factors were identified via exploratory factor analysis of 50 candidate items. Then, we conducted a hierarchical multiple regression analysis to investigate factors associated with each coping-behavior factor. We identified four types of coping behavior [CB1 (mask-wearing), CB2 (information-seeking), CB3 (resistance to social stagnation), and CB4 (infection-prevention)] and three risk-perception factors [RP1 (shortages of daily necessities), RP2 (medical concerns), and RP3 (socioeconomic concerns)]. CB1 was positively associated with female sex and etiquette. CB2 was positively related to RP1 and RP3. CB3 was positively related to RP1 and leadership, and negatively associated with etiquette. CB4 was positively associated with female sex, etiquette, and active well-being. This parsimonious model may help to elucidate essential social dynamics and provide a theoretical framework for coping behavior during a pandemic.

1. Introduction

Since the first case of coronavirus disease 2019 (COVID-19) was reported to the WHO, governments have spared no effort to prevent infection and transmission of this virus (1). As a health disaster (2), the response to this novel infectious disease is a public health issue that has had psychological and behavioral effects on individuals. Many studies have reported severe mental-health problems related to COVID-19, such as anxiety, depression, and suicide (3). People wore masks, disinfected their hands, and avoided crowds to prevent infection and transmission of the virus. Simultaneously, they had to manage the social disruption caused by

the pandemic and precautions, such as shortages of masks and toilet paper and losses of jobs and important events. In such a stressful environment, it is vital to understand how individuals managed adversity (i.e., both infection and general adversity) to try to maintain their current standard of living.

Recent studies have found positive associations between two types of coping behaviors (infection prevention and general-adversity coping behaviors) and risk perception. For example, self-isolation was found to be positively associated with risk perception of personal safety and health services (4). Information seeking was positively associated with perceived risk at the individual and community levels (5), while behavioral change (e.g., informing others about COVID-19) was positively associated with the perceived risk of infection (6, 7). This effect of risk perception on coping behavior is consistent with findings for other types of hazards, such as hurricanes, tornadoes, earthquakes, and volcanoes (8–13).

Psychobehavioral characteristics have been analyzed in recent studies of COVID-19 coping behavior. Recent COVID-19-related studies have extensively used the Big Five scale to explore the psychological mechanisms underlying coping behavior, as the characteristics in this scale have profound implications for public health (14). Their findings suggest that the Big Five personality traits are significantly associated with infection preventive behaviors (15–24). For example, extraversion, openness, conscientiousness, and agreeableness are positively associated with infection preventive behaviors, whereas neuroticism is negatively associated with such behaviors (15, 21).

However, a consensus regarding these findings is difficult to achieve due to the lack of a common model for the main coping-behavior and risk-perception factors, leading to labels that differ in their definition, level of specificity, or conceptual overlap in different studies. For example, coping behavior has been defined at different levels of specificity, such as infection prevention measures (15) but also as problem-focused and emotion-focused coping behaviors (25). Similar risk perception labels have been used to measure different phenomena. For example, risk perception has been used to represent the degree to which people perceive COVID-19 to be a dangerous disease (26) but also as a proxy for the level of knowledge of the risks associated with COVID-19 (5). Different labels have also been used to measure similar perceptions of risk, such as the likelihood of infection (21) and concerns related to COVID-19 (15). Furthermore, coping behavior and risk perception have not been fully distinguished. Researchers have attempted to identify risk-perception factors from risk-related items rather than from a mixed pool containing coping behaviors (15).

In addition, current studies have not investigated the contribution of survival-oriented psychobehavioral characteristics to coping behaviors, which may provide more nuanced insights into individual differences in the perceptions of and responses to pandemics as a health disaster. We are interested in the Power to Live scale, which was developed in the context of the 2011 Tohoku earthquake and tsunami. This scale assesses eight psychobehavioral characteristics that are advantageous to survival: leadership, problem-solving, altruism, stubbornness, etiquette, emotional regulation, self-transcendence, and active well-being. Compared to the Big Five scale, the Power to Live scale provides a more nuanced understanding of the relationships between psychobehavioral characteristics and coping behaviors, particularly in the context of disasters (12, 27, 28).

We aimed to address two issues in this study. First, we identified major coping-behavior and risk-perception factors. Then, we examined

important demographic, risk-perception, and psychobehavioral factors that contributed to coping behavior. We used a battery of questionnaires to investigate coping behaviors and risk perceptions in relation to COVID-19, as well as to obtain demographic information and measure psychobehavioral characteristics. We used the Power to Live scale based on our research interest and the Big Five scale according to previous studies (15–22). First, we conducted an exploratory factor analysis of various coping-behavior and risk-perception items to identify the major factors. Then, we examined the contributions of demographic, risk-perception (as an exploratory factor), and psychobehavioral characteristics to coping-behavior factors. We predicted that we would identify several coping-behavior and risk-perception factors associated with infection and general adversity. In addition to demographic and risk-perception factors, we hypothesized that associations would be found between coping-behavior factors and survival-oriented psychobehavioral characteristics.

2. Materials and methods

2.1. Participants

Data collection was conducted online by Neo Marketing (Tokyo, Japan) from March 19 to 24, 2020, during the early phase of the pandemic in Japan. The first coronavirus death had been reported (February 13); people had experienced the nationwide closure of elementary and junior high schools (March 2) and a national shortage of masks and toilet paper had occurred (March). The survey company emailed invitations to online crowdworkers living in all 47 prefectures of Japan. Participants were divided into six age groups (20s, 30s, 40s, 50s, 60s, and ≥70s) and two sex groups (male and female). Data were collected from 300 respondents in each sex and age group (total of 3,600 participants). All participants were required to have access to the Internet, to be familiar with working online, and to have sufficient time to fill in and submit the online questionnaire. Ultimately, we obtained data from 3,600 respondents (mean age = 49.73 ± 16.75 years). In addition to these 3,600 respondents, 481 participants were previously excluded due to inconsistencies between registered and reported demographic information or identical responses to all questions. We also excluded 715 satisfiers (i.e., people who presumably responded to the questions simply to meet the minimum requirements to finish the session, or people who responded carelessly) whose response time was <4 min (see the Supplemental material for further details regarding this criterion) resulting in a valid dataset of 2,885 individuals (1,524 women, mean age = 52.23 ± 16.52 years). No respondents had COVID-19.

2.2. Measures

The survey was developed in three sections (n = 104 in total), including five aspects of COVID-19-related items, consisting of coping behavior (n = 33), risk perception (n = 17), demographic questions (n = 10), and two psychobehavioral scales (n = 44).

2.2.1. Coping behavior and risk perception

We used 50 items to measure coping behavior and risk perception. These items were taken from previous studies or generated from interviews with people in our network (29, 30). We assessed five

aspects of coping behavior and risk perception: self-infection, other-infection, daily shortages of necessities, social and economic impacts, and information access (see Supplemental material).

2.2.2. Demographic information

The demographic questions included 10 items (Table 1): sex, age, place of residence, family structure, have toddlers or not, have children or not, reported local cases of infection, the degree of risk of self-infection becoming severe because of chronic disease or age (two separate items), and the degree of risk of severe disease among their family members because of underlying disease or age.

2.2.3. Psychobehavioral characteristics

We used the 34-item Power to Live scale, which measures eight psychobehavioral characteristics: leadership, problem-solving, altruism, stubbornness, etiquette, emotional regulation, self-transcendence, and active well-being. Previous studies have demonstrated internal consistency and concurrent validity of the scale (31, 32). Participants provided responses using a six-point scale (0: *Not at all*; 5: *Very much*). We calculated the mean score for each characteristic.

We also assessed the Big Five personality traits using the Japanese version of the Ten-Item Personality Inventory (TIPI-J). The TIPI-J has good internal consistency and concurrent validity (33, 34). Participants provided responses using a six-point scale (0: *Not at all*; 5: *Very much*). Each of the five dimensions (extraversion, agreeableness, conscientiousness, neuroticism, and openness) included a positive and a reverse item. Dimension scores were calculated by subtracting the score for the reverse item from that for the positive item.

3. Analysis

All analyses were performed in R (35) using the tidyverse (36), psych (37), GPArotation (38), EFA.MRFA (39), parameters (40), and effectsize (41) packages.

3.1. Exploratory factor analysis

We performed a factor analysis by pooling all of the coping-behavior and risk-perception items. The aim of the factor analysis was to dissociate coping behavior and risk perception by eliminating items that may convey similar nuances of both. First, we confirmed the appropriateness of the data for exploratory factor analysis by performing the Kaiser–Meyer–Olkin (KMO) test and Bartlett's test (42). The number of factors was determined based on the minimum average partial procedure (43), the Hull method (44), a parallel analysis (45), and a scree plot. We used the maximum likelihood method with Promax rotation because we assumed that the identified factors were correlated, and this method is well suited to simple structures (46). We excluded items if they met any of the following criteria: commonality <0.3, loading <0.4, or loading >0.4 on more than one factor (cross-loading). After removing an item, we repeated the analysis until all items met the criteria. The sum of squared (SS) loadings indicated the proportion of the variance explained by each factor. Cronbach's α was calculated for each factor to estimate internal consistency. Factor scores were calculated by averaging the scores of all items for each factor.

3.2. Correlation analysis

We performed a correlation analysis to explore the relationships among the identified coping-behavior factors, risk-perception factors, and psychobehavioral characteristics. Given the large sample size, we used $|r| > 0.3$ as the effect size threshold (47, 48).

3.3. Hierarchical regression analysis

To further explore the factors contributing to coping behavior and risk perception, we performed hierarchical regression analysis, which provides significant tests for the effects of independent variables on the dependent variable while controlling for the influence of the other independent variables.

We performed hierarchical regression analyses for each of the four coping-behavior factors. With the factor score as the dependent variable, we used 13 background factors in the first block, 3 risk-perception factors in the second block, and 13 psychobehavioral characteristics in the third block as explanatory variables.

We applied similar hierarchical regression models for each of the three risk-perception factors. We entered the 13 background-factor variables in the first block and the 13 psychobehavioral characteristics in the second block as explanatory variables.

Hierarchical regression analysis was performed using the stepwise method, and the variables were selected based on Akaike's information criterion. For each regression model, we calculated tolerance and the variance inflation factor to detect multicollinearity among predictors. Tolerance values <0.2 and variance inflation factor values >4 are considered problematic (49). Cohen's f^2 was used reflect the overall effect size of each block in the hierarchical regression (47). The term $f_{B/A}^2$ represents the effect size of each predictor (50). Due to the large sample size, we used a small effect size (i.e., Cohen's $f^2 = 0.02$) as the threshold.

4. Results

The demographic data are summarized in Table 1. The numbers and percentages of participants' demographic information are given for each item.

4.1. Exploratory factor analysis

The results of the KMO and Bartlett's tests indicated that the data were suitable for factor analysis (KMO = 0.92; χ^2 (1225) = 75783.41, $p < 0.001$). The minimum average partial, Hull method, and scree plot suggested extraction of eight factors, while the parallel analysis suggested extraction of 11 factors. Therefore, we selected an eight-factor solution; however, the results had a factor containing only two items. Thus, we eliminated one factor and reached a seven-factor solution following the suggestion that a factor should include at least three items (51). Finally, we removed nine items based on the commonality criterion and three items based on the two loading criteria; we thus achieved satisfactory results for the seven-factor solution (Table 2).

Table 2 shows the results of the seven factors. There were four coping-behavior factors: two related to infection, CB1,

TABLE 1 Demographic data of the participants.

Item		N
Sex	Male	1,361 (47%)
	Female	1,524 (53%)
Age	20s	364 (13%)
	30s	423 (15%)
	40s	470 (16%)
	50s	500 (17%)
	60s	548 (19%)
	≥70s	580 (20%)
Household structure	Single	525 (18.2%)
	Couple	888 (30.9%)
	Two generations (parents and children)	1,232 (42.8%)
	Three generations (parents, children, and grandchildren)	179 (6.1%)
	Other	61 (2.1%)
Toddlers in the household	Yes	250 (9%)
	No	2,635 (91%)
Children in the household	Yes	322 (11%)
	No	2,563 (89%)
Local cases of infection	Yes	1,109 (38%)
	No (including "*Do not know*" responses)	1776 (62%)
Knowledge	1 (I have no expertise or experience with infectious diseases)	1,043 (36%)
	2	597 (21%)
	3	582 (20%)
	4	458 (16%)
	5	162 (6%)
	6 (I have extensive expertise and experience with infectious diseases)	43 (1%)
Chronic disease	1 (I do not have a chronic disease that can cause severe infection)	1,666 (58%)
	2	437 (15%)
	3	194 (7%)
	4	228 (8%)
	5	173 (6%)
	6 (I have chronic diseases that can cause severe infection)	187 (6%)
High-risk age	1 (At my age, infection is unlikely to be severe)	1,021 (35%)
	2	457 (16%)
	3	367 (13%)
	4	417 (14%)
	5	344 (12%)
	6 (At my age, infection is likely to be severe)	279 (10%)
High-risk family members	1 (My family members are unlikely to develop severe infection because of chronic disease or age)	1,139 (39%)
	2	330 (11%)
	3	272 (9%)
	4	334 (12%)
	5	332 (11%)
	6 (My family members are likely to develop severe infection because of chronic disease or age)	478 (17%)

Ordinal variables (e.g., age) were coded according to degree. Binary variables were coded as 1 or 0 [i.e., sex (male = 1; female = 0) and yes/no items ("Yes" = 1, "No = 0")]. Household structure was coded as a dummy variable.

TABLE 2 Factor analysis of the COVID-19 questionnaire.

Items	CB1	RP1	CB2	RP2	CB3	RP3	CB4	α
CB1: Mask-wearing								**0.89**
I wear a mask to avoid infecting others	**1.02**	−0.07	0.03	−0.01	−0.01	−0.01	−0.09	
I wear a mask so that people around me do not feel uncomfortable if I cough or sneeze	**0.98**	−0.05	−0.01	−0.04	−0.02	0.01	−0.03	
I wear a mask to prevent myself from becoming infected	**0.71**	0.01	−0.02	0.01	0.06	−0.08	0.14	
I cover my mouth and nose when I cough or sneeze to avoid infecting others	**0.47**	0.04	−0.02	0.00	−0.11	0.15	0.23	
RP1: Shortages of daily necessities								**0.79**
I am worried about shortages of daily necessities caused by disruptions in production and distribution related to the spread of infection	−0.04	**0.99**	0.01	−0.05	−0.10	−0.01	0.07	
I am worried that daily necessities may not be sufficient because of hoarding	−0.04	**0.92**	−0.03	−0.03	−0.08	−0.03	0.08	
I am worried that lifelines (water, gas, electricity) may be cut off because of the social chaos caused by the spread of infection	0.00	**0.44**	0.01	0.08	0.25	0.00	−0.12	
CB2: Information-seeking								**0.92**
I frequently check the national and local governments' responses to the COVID-19 pandemic and predictions about what will happen	−0.02	−0.02	**0.93**	−0.01	−0.13	0.01	0.05	
I frequently check on the number of people infected with the coronavirus	0.02	0.01	**0.91**	−0.01	−0.14	−0.02	−0.01	
I frequently check on the social and economic impacts of infection control	−0.04	−0.02	**0.82**	0.01	−0.04	0.08	0.06	
I frequently check on the shortages of daily necessities	0.02	0.13	**0.71**	−0.03	0.11	−0.07	−0.02	
I collect information from specialized organizations, such as the Ministry of Health, Labor, and Welfare	0.00	−0.11	**0.70**	0.03	0.20	−0.05	0.02	
I monitor COVID-19-related news on TV and in the newspapers	0.01	0.00	**0.68**	−0.05	−0.12	0.15	0.06	
I spend time searching for COVID-19-related information on the internet	−0.01	0.01	**0.67**	0.03	0.16	−0.01	−0.08	
RP2: Medical concerns								**0.87**
I am worried that I will become infected	−0.04	−0.10	−0.01	**0.91**	−0.03	−0.02	0.09	
I am worried that my family and friends will become infected	−0.07	−0.05	−0.05	**0.85**	−0.08	−0.00	0.11	
I am worried that I will be infected and it will be serious	0.00	−0.11	0.08	**0.74**	−0.04	−0.08	0.07	
I am worried that many people around us will become infected	−0.06	−0.06	−0.04	**0.68**	0.10	−0.01	−0.01	
I am worried about infecting others (if I were infected)	0.06	−0.01	−0.01	**0.67**	0.06	−0.01	−0.07	
I am worried that people around me may think that I am infected and feel anxious when I cough	0.07	0.07	0.00	**0.56**	0.06	0.01	−0.04	
When I or my family members are infected, I am worried that I will not be able to respond appropriately	0.01	0.08	−0.04	**0.53**	−0.07	0.06	−0.06	

(Continued)

TABLE 2 (Continued)

Items	CB1	RP1	CB2	RP2	CB3	RP3	CB4	α
When I or my family are infected, I am worried that the medical system will not be adequate to manage the infection	−0.01	0.17	−0.01	**0.48**	−0.13	0.10	0.03	
CB3: Resistance to social stagnation								**0.80**
I get together with my friends and relatives to stay in touch, particularly during these times	−0.02	−0.01	−0.05	−0.06	**0.76**	0.00	0.06	
I try to spend my money, particularly during these times	−0.01	−0.10	−0.08	0.03	**0.69**	0.00	−0.01	
I communicate using the phone, email, or text, particularly during these times	−0.01	−0.03	0.03	−0.04	**0.69**	0.03	0.12	
I try to do fun things, particularly during these times	−0.05	−0.03	−0.11	−0.08	**0.65**	0.14	0.13	
I try to advise my friends and acquaintances not to buy extra things that they do not need right now	−0.02	0.05	0.06	−0.01	**0.54**	−0.1	0.07	
I advise my friends and acquaintances to stockpile daily necessities	0.10	0.07	0.11	0.06	**0.51**	−0.15	−0.05	
I am worried that refraining from events will lead me to lose events that are important in my life	0.01	0.01	0.03	0.04	**0.44**	0.26	−0.16	
RP3: Socioeconomic concerns								**0.83**
I am worried that the spread of infection will not be under control after April and that this situation will continue	0.00	−0.09	0.01	0.02	−0.06	**0.92**	−0.01	
I am worried that the situation may worsen in the future, causing further turmoil in society	0.00	−0.07	0.01	0.07	0.07	**0.85**	−0.09	
I am worried that economic stagnation could affect many people because of poor corporate balance, bankruptcy, and job loss.	0.00	0.09	0.07	−0.03	−0.10	**0.61**	0.11	
I am worried that refraining from events will lead many people to lose events that are important in their lives	0.01	0.03	0.00	−0.03	0.12	**0.56**	0.04	
CB4: Infection-prevention								**0.81**
I ventilate rooms to prevent infection	−0.04	0.07	0.00	0.00	0.16	−0.08	**0.72**	
I have been washing my hands well and gargling regularly	0.11	0.09	−0.09	0.01	0.02	0.05	**0.66**	
I avoid going to crowded places	−0.04	0.01	0.05	0.02	−0.10	0.06	**0.65**	
I am careful about physical condition management, such as eating, exercising, and sleeping	−0.05	−0.04	0.07	−0.01	0.07	0.03	**0.63**	
I try not to touch door handles or buttons that are touched by many people unknown to me	0.07	−0.04	0.04	0.08	0.14	−0.07	**0.59**	
SS loadings	2.79	2.18	4.34	3.89	3.01	2.47	2.37	
Cumulative variance	0.07	0.13	0.24	0.35	0.43	0.49	0.55	

Loadings ≥ 0.40 are in bold. α: Cronbach's alpha.

mask-wearing (representing mask use related to infection prevention behavior); and CB4, infection-prevention (representing general infection prevention measures, such as hand washing); and two related to general adversity, CB2, information-seeking (searching for or checking COVID-19-related information) and CB3, resistance to social stagnation. The CB3 label was based on the fact that all described behaviors serve to prevent social stagnation. This stagnation may be caused by reduced communication, reduced economic activity, and psychological depression. Items 5 and 6 are also behaviors that counteract social disorders, albeit from different viewpoints. There were three risk-perception factors: one related to infection, RP2, medical concerns (indicated concerns about medical resources and becoming infected); and two related to general adversity, RP1, shortages of

daily necessities (measured concerns about shortages of daily supplies) and RP3, socioeconomic concerns (represented concerns about society and the economy). The internal consistency coefficients (Cronbach's α) of all factors were >0.70. They constituted 55% of the total variance.

4.2. Correlation analysis

Among the coping-behavior factors, information-seeking (CB2) was significantly associated with all other coping-behavior factors (CB1, CB3, and CB4) and socioeconomic concerns (RP3). Furthermore, mask-wearing (CB1) was associated with infection-prevention (CB4). Three risk-perception factors were significantly associated with each other; socioeconomic concerns (RP3) were significantly associated with mask-wearing (CB1) and information-seeking (CB2) (Table 3).

All four coping-behavior factors were significantly associated with at least one characteristic in the Power to Live scale, but the risk-perception factors did not demonstrate such associations. Both infection prevention factors (CB1 and CB4) were associated with etiquette; infection-prevention (CB4) was additionally associated with problem-solving,

emotional regulation, self-transcendence, and active well-being. Both general-adversity coping behaviors (CB2 and CB3) were associated with leadership, altruism, and active well-being; information-seeking (CB2) was additionally associated with problem-solving, etiquette, and self-transcendence. However, no significant associations were observed between factors and Big Five characteristics (Table 3).

4.3. Hierarchical regression analysis

Tolerance and variance inflation factor analyses indicated no evidence of multicollinearity in any hierarchical regression.

Table 4 summarizes the results of the four coping-behavior factors (see Supplementary Tables S1–S4 online). Among the demographic factors, sex negatively contributed to two infection prevention factors (CB1 and CB4). Among risk-perception factors, shortages of daily necessities (RP1) significantly contributed to two general-adversity coping behaviors (CB2 and CB3), while socioeconomic concerns (RP3) positively contributed to information-seeking (CB2). However, medical concerns (RP2) did not contribute to any of the coping behaviors. Among the psychobehavioral characteristics, etiquette was positively associated with two infection prevention factors (CB1 and

TABLE 3 Correlation matrix for coping-behavior factors, risk-perception factors, and psychobehavioral characteristics.

		Coping behaviors				Risk perceptions		
		CB1	CB4	CB3	CB2	RP2	RP1	RP3
CB1	Mask-wearing	—						
CB4	Infection-prevention	**0.574***	—					
CB3	Resistance to social stagnation	0.135*	0.228*	—				
CB2	Information-seeking	**0.374***	**0.467***	**0.380***	—			
RP2	Medical concerns	0.230*	0.159*	0.137*	0.237*	—		
RP1	Shortages of daily necessities	0.250*	0.180*	0.236*	0.279*	**0.419***	—	
RP3	Socioeconomic concerns	**0.309***	0.259*	0.170*	**0.347***	**0.340***	**0.457***	—
	Power to Live							
	Leadership	0.152*	0.299*	**0.468***	**0.355***	−0.043	0.017	0.072*
	Problem-solving	0.229*	**0.367***	0.217*	**0.304***	−0.020	0.070*	0.209*
	Altruism	0.188*	0.217*	**0.311***	**0.301***	0.068*	0.104*	0.155*
	Stubbornness	0.088*	0.135*	0.171*	0.182*	0.049	0.101*	0.147*
	Etiquette	**0.355***	**0.437***	0.094*	**0.315***	0.021	0.083*	0.255*
	Emotional regulation	0.186*	**0.353***	0.256*	0.293*	−0.041	0.029	0.153*
	Self-transcendence	0.254*	**0.368***	0.270*	**0.349***	0.030	0.078*	0.196*
	Active well-being	0.200*	**0.391***	**0.342***	**0.354***	−0.024	0.043	0.124*
	Big Five							
	Extraversion	0.055	0.131*	0.248*	0.161*	−0.102*	−0.064*	−0.011
	Agreeableness	0.217*	0.244*	0.007	0.178*	−0.108*	−0.043	0.102*
	Conscientiousness	0.126*	0.296*	0.073*	0.195*	−0.155*	−0.108*	−0.011
	Neuroticism	−0.025	−0.165*	−0.094*	−0.091*	0.210*	0.164*	0.079*
	Openness	0.004	0.126*	0.269*	0.157*	−0.050	−0.017	−0.015

$|r| > 0.3$ are in bold. *: p-values < 0.001.

TABLE 4 Hierarchical regression analysis of coping-behavior factors.

	Mask-wearing		Infection-prevention		Resistance to social stagnation		Information-seeking	
	β	$f_{B/A}^2$	β	$f_{B/A}^2$	β	$f_{B/A}^2$	β	$f_{B/A}^2$
Sex	−0.232*	**0.059**	−0.179*	**0.035**	−0.026	0.001	−0.061*	0.004
Knowledge	0.078*	0.007	0.143*	**0.022**	0.176*	**0.032**	0.155*	**0.026**
Local case of infection	0.067*	0.005	0.084*	0.008			0.079*	0.007
Hs_single	−0.037	0.001	−0.027	0.001			−0.066*	0.005
High-risk age	0.167*	**0.030**	0.120*	0.010			0.156*	0.016
Toddler			0.053	0.003	0.033	0.001	0.036	0.001
Age			0.086*	0.005			0.110*	0.008
Child					0.057	0.003		
Hs_couple			0.035	0.001				
Block 1		0.106		0.119		0.037		0.119
ΔR^2		0.096		0.106		0.036		0.106
ΔF		61.150*		42.759*		26.994*		48.733*
Medical concerns	0.068*	0.004	0.041	0.002			0.074*	0.005
Shortages of daily necessities	0.109*	0.010	0.084*	0.006	0.200*	**0.035**	0.159*	**0.023**
Socioeconomic concerns	0.209*	**0.041**	0.19*	**0.033**	0.072*	0.005	0.237*	**0.056**
+Block 2		0.116		0.076		0.064		0.175
ΔR^2		0.094		0.063		0.058		0.133
ΔF		111.065*		72.681*		92.179*		167.796*
Leadership					0.483*	**0.118**	0.178*	0.015
Problem-solving					−0.177*	0.014	−0.076	0.003
Altruism	−0.042	0.002	−0.083*	0.006	0.101*	0.009	0.043	0.002
Stubbornness			−0.061	0.004	−0.052	0.003		
Etiquette	0.194*	**0.023**	0.181*	**0.022**	−0.250*	**0.043**		
Emotional regulation	−0.043	0.001	0.056	0.002	0.084*	0.004		
Self-transcendence	0.053	0.001	0.042	0.002	0.047	0.001	0.057	0.002
Active well-being	0.058	0.002	0.191*	**0.027**	0.163*	0.018	0.154*	0.016
Extraversion					−0.047	0.002	−0.035	0.001
Agreeableness	0.107*	0.011	0.034	0.002	−0.094*	0.009		
Conscientiousness			0.135*	0.019	−0.038	0.002	0.052	0.003
Openness	−0.035	0.001			0.103*	0.012		
+Block 3		0.087		0.222		0.429		0.130
ΔR^2		0.065		0.151		0.272		0.087
ΔF		35.744*		79.676*		102.521*		53.093*

*: p-values < 0.001; $f_{B/A}^2 > 0.02$ are in bold; High-risk age: the age at which infection is likely to be severe. HS, household structure. Variables selected by the stepwise method are presented.

CB4), while it was negatively associated with behaviors protecting against social stagnation (CB3). Leadership and active well-being were positively associated with resistance to social stagnation (CB3) and infection-prevention (CB4), respectively.

Table 5 displays a summary of the results for the risk-perception factors (see Supplementary Tables S5–S7 online). Among the demographic factors, age, high-risk age, and having a high-risk family member significantly contributed to medical concerns (RP2), but age demonstrated a negative association. Among psychobehavioral characteristics, etiquette contributed only to socioeconomic concerns (RP3). Table 6 shows the

relationships of demographic information, risk-perception factors, and psychobehavioral characteristics with coping-behavior factors.

5. Discussion

The main goal of this study was to identify major coping-behavior factors while exploring the contributions of demographic information, risk-perception factors, and psychobehavioral characteristics to coping-behavior factors. We identified four coping-behavior factors (two

TABLE 5 Hierarchical regression analysis of risk-perception factors.

	Medical concerns		Shortages of daily necessities		Socioeconomic concerns	
	β	$f_{B/A}{}^2$	β	$f_{B/A}{}^2$	β	$f_{B/A}{}^2$
Age	−0.296*	**0.061**	−0.225*	**0.031**	−0.138*	0.011
High-risk age	0.351*	**0.054**	0.149*	0.011	0.197*	0.014
High-risk family member	0.177*	**0.029**	0.089*	0.006	0.073*	0.004
Sex			−0.048	0.002	−0.031	0.001
Child	0.030	0.001	0.042	0.002		
Local case of infection	0.039	0.002			0.048	0.002
Chronic disease	0.088*	0.006			−0.056	0.002
HS_two generations	0.040	0.002				
Knowledge					0.028	0.001
Block 1		0.249		0.052		0.037
ΔR^2		0.199		0.050		0.035
ΔF		102.241*		30.109*		15.028*
Leadership					−0.102*	0.006
Problem-solving	0.171*	0.013	0.080	0.002	0.163*	0.010
Altruism	0.060	0.003	0.053	0.002		
Stubbornness			0.036	0.001	0.055	0.002
Etiquette	0.046	0.001	0.096*	0.004	0.213*	**0.023**
Emotional regulation	−0.061	0.002				
Self-transcendence			0.042	0.001	0.057	0.002
Extraversion	−0.076*	0.006	−0.069*	0.004		
Agreeableness	−0.100*	0.009	−0.048	0.002	0.053	0.002
Conscientiousness	−0.110*	0.010	−0.085*	0.005	−0.087*	0.006
Neuroticism	0.128*	0.013	0.141*	0.014	0.149*	0.017
Openness			0.032	0.001		
+Block 2		0.074		0.060		0.128
ΔR^2		0.055		0.054		0.109
ΔF		26.601*		17.261*		45.795*

Other details are as shown in Table 4.

related to infection and two related to general adversity) and three risk-perception factors (one related to infection and two related to general adversity). Female sex and etiquette promoted infection prevention behaviors (CB1 and CB4), whereas shortages of daily necessities (RP1) promoted general-adversity coping behaviors (CB2 and CB3). Active well-being promoted infection-prevention (CB4), and socioeconomic concerns (RP3) promoted information-seeking (CB2). Resistance to social stagnation (CB3) was inhibited by etiquette and promoted by leadership. Although some of the correlations between the Big Five scale and coping-behavior factors were consistent with previous studies (15, 21), none of them reached our effect-size threshold (Table 6).

The factors promoting infection prevention behaviors in this study were consistent with existing knowledge. Our findings showed that etiquette and female sex contributed to two infection prevention factors, while medical concerns (RP2) did not. Etiquette was defined as adherence to social norms (32), and infection prevention behaviors may arise from the desire to comply with social norms. Our finding that medical concerns (RP2) lacked an association with infection prevention

behaviors while etiquette was associated with infection prevention behaviors was consistent with a previous Japanese study, in which mask-wearing was related to social norms rather than the perceived risk of COVID-19 (52). In addition, our finding that women were more inclined to exhibit infection prevention behaviors was consistent with studies in which women were more willing to self-isolate (53) and more frequently engaged in positive coping behavior than men (54).

There are two potential reasons for the identification of two infection prevention factors in this study (i.e., mask-related and mask-unrelated). The first involves the executability of the two types of infection prevention. The availability of masks may have caused a separation of infection prevention due to the severe shortage and hoarding of masks that occurred during the early stage of the pandemic (55). The second reason involves the emphasis on wearing masks. The Ministry of Health, Labor, and Welfare released 61 documents concerning the latest domestic coronavirus situation in 77 days [1/1/2020–3/18/2020 (immediately before the survey)]; each of the documents included the same message to the public that

TABLE 6 Summary of the contributions of various factors to coping-behavior factors.

		Infection		General adversity	
		CB1 Mask-wearing	CB4 Infection-prevention	CB2 Information-seeking	CB3 Resistance to social stagnation
Demographic information	Female sex	+	+		
Risk-perception factors	RP1 Shortages of daily necessities			+	+
	RP3 Socioeconomic concerns			+	
Psychobehavioral characteristics	Leadership				+
	Etiquette	+	+		−
	Active well-being		+		

wearing masks and washing hands are important practices (56). Most indoor and public places required a mask before entering. Thus, people could be divided into two groups: a group that wore masks and followed the mask-wearing recommendation and a group that lacked masks and focused more on general infection prevention.

Shortage of daily necessities (RP1) is a common facilitative factor of general-adversity coping behaviors. Media-dependency theory claims that people become increasingly dependent on social media during severe social disruption (57). Consistent with this theory, our results reveal that individuals tended to use information-seeking strategies (CB2) to be informed, prepared, and responsive to COVID-19 when they knew about shortages of daily necessities. The contribution of shortages of daily necessities (RP1) to resistance to social stagnation (CB3) is congruent with the results of the disaster research described in the Introduction. Shortage of daily necessities, while not totally representing social stagnation, might be seen as an early warning sign of subsequent social stagnation in multiple fields, such as long-lasting impacts on the supply chain (58). Thus, when our participants perceived an existing threat to society (i.e., shortage of daily necessities), they may have responded as if social stagnation was imminent.

However, each of the two general-adversity coping-behavior factors had unique features. Except for shortages of daily necessities (RP1), information-seeking (CB2) was facilitated by socioeconomic concerns (RP3); resistance to social stagnation (CB3) was inhibited by etiquette and enhanced by leadership. The relationship between information-seeking (CB2) and socioeconomic concerns (RP3) is also consistent with the media-dependency theory: perceived social risk enhances information-seeking. The negative contribution of etiquette to resistance to social stagnation (CB3) may have originated from obedience to guidance. For instance, people with high etiquette scores are more likely to maintain social distance and limit their engagement in non-essential activities. On the other hand, people with strong etiquette skills might attempt to maintain their usual routines as before. They may not implement strategies to resist social stagnation because fussiness also violates social norms (59). The essence of leadership refers to the tendency to solve problems through communication, which may explain directly its contribution to responses to imminent social stagnation (CB3). An example item of leadership in the Power to Live scale is: "To resolve problems, I gather everyone involved together to discuss the matter." People with strong leadership are more likely to take the initiative to reach out to others and solve problems. Previous studies have reported a contribution of

leadership to spontaneous evacuation efforts in the context of an imminent tsunami (12), including encouraging other people to evacuate (27) and resolving problems through mutual aid (28).

Our study implies that each coping behavior has distinct facilitatory/inhibitory psychological processes supported by a partial conflict between survival-oriented characteristics. Etiquette facilitated two infection prevention factors (CB1 and CB4) but inhibited the general-adversity coping-behavior factor (i.e., CB3; resistance to social stagnation). This conflict may be the result of a trade-off between infection prevention and general-adversity coping behaviors. For example, maintaining social distance (or self-isolation) is an effective and critical method to stop transmission. However, people may not be able to attend important events or socialize, which makes them feel socially isolated and impairs both physical and mental health.

In summary, our results provide a theoretical framework for sorting out the apparently chaotic social responses to the pandemic into a comprehensive picture by identifying its major factors and investigating the psychobehavioral mechanism underlying each factor. Previous studies have addressed only the psychological factors involved in social responses to the COVID-19 pandemic (4, 5, 15, 21, 52, 60). Our findings imply that coping behaviors can be classified into two categories: infection prevention (CB1: mask-wearing and CB4: infection-prevention) and coping with general adversity (CB2: information-seeking and CB3: resistance to social stagnation). The former behaviors were associated with female sex and etiquette, and the latter behaviors were associated with concerns regarding shortages of daily necessities (RP1). Additionally, infection-prevention (CB4) was facilitated by active well-being. Information-seeking (CB2) was promoted by socioeconomic concern (RP3) and resistance to social stagnation (CB3) was facilitated by leadership and suppressed by etiquette. The opposite associations of etiquette between two infection prevention factors (CB1 and CB4) and resistance to social stagnation (CB3) may underlie trade-offs between these two types of coping behaviors; this perspective may become evident only in this comprehensive framework.

Our framework provides policymakers with a comprehensive picture of a public with different characteristics, the associated coping behaviors exhibited, and their contexts. This may help them to implement policies that maximize social benefits. For instance, to prevent overresponses to adversity, national and local governments can take steps to reduce concerns about shortages of daily necessities, such as by ensuring adequate supplies. It is important to note that increased concern can have unexpected consequences: increased concern about medical issues is unlikely to facilitate infection prevention behaviors, but

increased socioeconomic concern may facilitate people's information seeking and lead to an "infodemic" (61). To optimize the balance between infection prevention and resistance to social stagnation, governments should take age- and culture-specific psychobehavioral characteristics (i.e., leadership, etiquette, and active well-being) into account, or consider educational and intervention approaches to affect such psychobehavioral characteristics. Based on the current theoretical framework, the development of such a set of strategic social approaches to pandemics appears promising.

Our study had several limitations. First, our work may be preliminary with regard to building a comprehensive model; a truly comprehensive model would integrate results for multiple periods characterized by different social responses. It is necessary to consider survey results from other periods. However, we do not consider the current data to be less valuable than such results. Our data reflected the social situation in the early days of the pandemic when the features of COVID-19 were largely unknown, and people's fears were at their highest. Social turmoil caused by the shortage of masks and toilet paper, for example, was also unique to this period. Second, the comprehensiveness of our results pertains only to individuals without COVID-19 infection, as none of our participants had COVID-19. Third, the sample is limited in its representativeness. Despite efforts to recruit participants from different generations from all over Japan, we acknowledge that the sample may not fully represent the larger population of interest. Finally, this study used self-report measures and included only Japanese participants, which may limit the generalizability of the findings. Moreover, there may have been response biases, such as population and optimism biases, where the participants were all familiar with online surveys and may have overestimated their knowledge of infectious diseases or underestimated the risk of disease. Such biases could have affected the relationships among the variables. Future studies could conduct experiments in other cultures and use other data-collection approaches to enhance the robustness and generalizability of the findings.

6. Conclusion

We proposed a new model comprising four independent coping-behavior factors and three risk-perception factors for COVID-19, which were categorized into infection-related and general adversity-related groups. We have demonstrated that infection prevention and coping with general adversity were associated with different factors. Female sex and etiquette promoted two infection prevention factors, while shortages of daily necessities promoted two general-adversity coping behavior factors. In addition, infection-prevention (CB4) was promoted by active well-being, and information-seeking (CB2) was promoted by socioeconomic concerns; meanwhile, resistance to social stagnation (CB3) was inhibited by etiquette and promoted by leadership. This study provides a theoretical framework for coping behaviors and risk perception during a pandemic and demonstrates their underlying psychobehavioral mechanisms. The contribution of demographic, risk-perception, and psychobehavioral characteristics to coping behavior could help policymakers devise effective strategies for optimizing social responses to pandemics. Future research should continue to refine this model of perceived risk and coping behavior, and including more data from different periods of the epidemic would greatly improve the model. Moreover, future studies can use this model to investigate how mental health and emotional distress affect different types of coping behavior.

Data availability statement

The datasets presented in this study can be found in online repositories. The names of the repository/repositories and accession number(s) can be found at: https://osf.io/t4suw/.

Ethics statement

The studies involving humans were approved by Ethical Committee of the International Research Institute of Disaster Science, Tohoku University (2019-035). 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

YD and MS designed the experiment. YD analyzed the data and wrote the initial draft of the manuscript. All authors contributed to the article and approved the submitted version.

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Conflict of interest

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

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Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyt.2023.1200473/full#supplementary-material

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Translation, adaptation, and initial evaluation of a guided self-help intervention to reduce psychological distress among nurses during COVID-19 in China

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Background: This study aimed to reduce the unprecedented and intense psychological distress that nurses were forced to experience during the COVID-19 pandemic. A Chinese version of the World Health Organization's Self-Help Plus (SH+) intervention guide was adapted and tested among nurses. The objective of this study was to translate and adapt the SH+ guideline into the Chinese version and to test its feasibility in reducing psychological distress among nurses during COVID-19.

Methods: A staged approach comprising translation, adaptations, initial evaluation by pilot implementation, and a qualitative process evaluation was conducted in two hospitals in Xi'an, China. The translation of the Chinese version was authorized by the World Health Organization. We adapted SH+ for use among clinical nurses working during the pandemic in China through a qualitative process evaluation, which was guided by the descriptive phenomenological study design. The outcomes of the pilot included psychological distress, psychological flexibility, depressive and anxiety symptoms, post-traumatic stress disorder (PTSD) symptoms, and subjective psychological wellbeing, which were assessed using the Kessler 6 symptom checklist, the Comprehensive Assessment of ACT Process (CompACT), the Patient Health Questionnaire-9 (PHQ-9), the Generalized Anxiety Disorder scale (GAD-7), the PTSD Checklist-Civilian Version (PCL-C), and the Index of Wellbeing (IWB), respectively.

Results: The SH+ materials, including audio-recorded sessions and an accompanying illustrated manual, were translated into Chinese and adapted in line with feedback from the nurses. An uncontrolled pilot study ($n = 28$) for 5 weeks showed a statistically significant reduction of psychological distress (mean difference in Kessler 6 score, -2.74; 95% CI [-3.71, -1.78]; $p < 0.001$). We also found improvements in psychological flexibility (mean difference in CompACT score, 6.89; 95% CI [-12.35, -4.47]; $p < 0.001$), subjective psychological wellbeing (mean difference in IWB score, 0.86; 95% CI [0.07, 1.65]; $p < 0.05$), and depressive symptoms (mean difference in PHQ-9 score, -1.52; 95% CI [-2.78, -0.26]; $p < 0.05$). The process evaluation showed that nurses found the SH+ program very useful but difficult to adhere to.

Conclusion: We found that the translated Chinese version of SH+ was applicable and feasible in the Chinese cultural context. There was a potential effect of adapted SH + in reducing nurses' psychological distress during COVID-19 and suggested the value of exploring strategies to increase adherence to the program.

1. Introduction

The outbreak of COVID-19 has posed a serious public health threat worldwide in the past 3 years. Studies found that with a high rate of infection and death, COVID-19 led to moderate-to-severe psychological problems, including psychological distress, anxiety, depression, fear, psychosomatic preoccupations, and insomnia in the general public (1, 2). Facing this critical situation, the nurses were one of the groups most severely affected by the COVID-19 pandemic, leaving them with serious psychological effects, given their risk of exposure to the virus, concerns about infecting and caring for their loved ones, longer work hours, and shortages of personal protective equipment (1, 3). Studies reported that a considerable proportion of nurses were experiencing high levels of depression, anxiety, psychological distress, post-traumatic symptoms, burnout, and insomnia (4–6). A systematic review showed that the pooled prevalence rate of psychological distress among nurses during the COVID-19 outbreak was 46.1% (7). Despite the passage of time after the epidemic began, there were still psychological repercussions for nurses as a result of increased labor and exhaustion (3, 8), which highlighted the need for designing a targeted intervention to improve mental health and foster post-traumatic recovery among nurses.

Psychological distress is a response to specific stressors or demands and is characterized by a perceived inability to effectively cope with the stressors, a change in emotional state (such as stress, anxiety, and depression), and an expression of discomfort that causes either temporary or permanent harm to the person (9). The cost of psychological distress among nurses is high since it can result in fatigue, impoliteness, anxiety, an increase in blood pressure, a lack of self-confidence, and a decline in productivity (10). Consequently, it is imperative to develop strategies to promote the mental health and wellbeing of nurses throughout the COVID-19 pandemic and beyond.

However, multiple barriers are limiting the implementation and ability of current conventional interventions for the management of distress in nurses. Evidence-based interventions for nurses' psychological distress remain scarce in the literature (11). Moreover, it is hard to deliver long-term universal psychological care to nurses due to shift hours, an overload of work commitments, and a lack of time to attend sessions. Traditional face-to-face psychotherapy is particularly hard to implement immediately and regularly for nurses working in the context of quarantine policy due to the pandemic. Additionally, traditional psychotherapy interventions generally require a substantial clinical

workforce, such as mental health specialists and specialist facilities, which are especially not available in developing countries (12). Furthermore, recent experiences in China demonstrate that not all nurses willingly partake in group or individual psychological interventions due to the stigma surrounding mental health issues (13).

Given these challenges, urgent attention must be paid to the exploration of feasible strategies to enhance nurses' access to evidence-based psychological interventions during the COVID-19 pandemic. In an effort to make available a series of scalable psychological interventions, the WHO and a number of institutions have proposed guidelines for the provision of psychological assistance to healthcare workers during this pandemic (14). The Self-Help Plus (SH+) program is a guided, multi-media, self-help intervention that is part of the WHO's flagship mental health gap action program (mhGAP). SH+ is a low-intensity psychological intervention for stress management and overcoming a variety of adversities (15) and is informed by various meta-analyses of its therapeutic ingredients. It has been translated into several languages (Spanish, Arabic, French, Greek, Japanese, etc.) and has been implemented in many countries (16). The intervention is founded on the principles of Acceptance and Commitment Therapy (ACT), a third-wave cognitive-behavioral therapy intended to increase psychological flexibility (17). Evidence has shown that ACT has promising effects on stress, anxiety, depressive symptoms, and quality of life (18). The central construct of ACT is psychological flexibility (PF), which is defined as an individual's 'ability to contact the present moment more fully as a conscious human being and to change or persist in behavior when doing so serves valued ends' (17). Studies have shown that ACT is a suitable intervention in a self-help format, particularly when clinician guidance is given (19). Compared to conventional psychotherapy, the guided self-help ACT approaches were cheaper and easily accessible and offered a feasible alternative to resource-constrained psychotherapeutic interventions (19, 20). Given these findings, we expected that adaptations would be required to enhance acceptability, feasibility, and satisfaction with the intervention in this socio-cultural context.

In this article, we describe the translation, adaptation, and initial evaluation of SH+ with nurses during COVID-19 in China. The purpose of this research was to adapt SH+ for the Chinese population and to determine the acceptability, comprehensibility, and cultural Relevance of the guided self-help model for reducing psychological distress in nurses.

2. Materials and methods

2.1. Study design

An approach with three phases for translation, adaptation, and piloting was utilized, including (1) translation and adaptations; (2) pilot implementation; and (3) process evaluation.

2.1.1. Phase 1: translation and adaptations

For this phase, the translation and adaptations of the WHO-SH+ manual, as well as the handbook and audio materials, were completed. Translation and adaptations were conducted in three steps: (a) translation by a team of bilingual researchers; (b) adaptation by an expert group; and (c) pre-testing and cognitive interviewing.

The translation and adaptations of SH+ intervention materials (guidelines, illustrations, and recordings) were guided by the Bernal framework of translation and adaptation of interventions, which includes eight dimensions: language, persons, metaphors, content, concepts, goals, methods, and context (21). Not only does the framework provide a useful documentation method, but it also permits translators and experts to concentrate on the key dimensions that need to be adapted (22). Cognitive interviewing was used to conduct a pre-test that guided the adaptation process. Cognitive interviewing is a common technique for validating the accuracy of health questionnaires or interventions created in one cultural context and then implemented in another language and culture (23).

2.1.1.1. Translation

The original English version of the SH+ manual was provided by the World Health Organization (16), and permission was obtained to translate and adapt it into the Chinese context. The translation process was conducted by three investigators (XL, LY, and TT, native Chinese), led by a psychological nursing professional (XL). A forward translation of the complete SH+ materials was produced by two translators (LY and TT). Then, the translation was reviewed and edited by a senior translator (XL).

2.1.1.2. Adaptations

The adaptations were conducted through a face-to-face group meeting and an online meeting with a group of mental health experts/mental health professionals (four per group) by facilitators. Experts from the professional group were from different areas, including two psychological nursing professionals (XL and JL) and two experts from the Institute of Psychology, Chinese Academy of Science (ZL and RW). The facilitators (ZH and JS) were members of the research team who were familiar with the SH+ manual and the procedures for its adaptation and piloting. Facilitators' responsibilities included (a) briefing the participants and organizing groups to work more effectively; (b) supporting the intervention process and monitoring the intervention sessions received by the participants during piloting; and (c) reporting the process.

Through discussions of any problematic items with the expert group, consistency was achieved at both the technical level (i.e., wording, grammar, tense, punctuation, and the acceptable level

of abstraction) and the conceptual level (obtaining an identical meaning of concepts that may have different cultural expressions, such as idioms and metaphors). In addition to revising the cultural adaptation of the language and illustrations, the expert group suggested the context and conditions for program delivery. In addition, parts of the illustrations in the SH+ manual were modified or re-drawn by two Chinese artists to suit the Chinese context (e.g., changing characters, styles of clothing, dressing up, and environment).

2.1.1.3. Cognitive interviews

The cognitive interview approach was applied to gain the perspectives of the users, i.e., nurses, to guide further adaptation. A total of 14 nurses of both sexes and various ages from the First Affiliated Hospital of Xi'an Jiaotong University who have experience in caring for infected patients or have performed other related work in the quarantine area during the COVID-19 pandemic participated in interviews. They were divided into groups of 3–4 participants. We asked them to read the handbook, listen to the audio, and watch the exercise video individually. Following this, the facilitators obtained their feedback and noted any concerns they might have. A structured questionnaire regarding comprehensibility, acceptability, relevance, and any proposed changes was administered. Finally, any potential changes were summarized in a structured form, discussed by the research team, and incorporated into the adapted manual and audiovisual material.

Detailed instructions for the cognitive interview are provided in Appendix 1.

2.1.2. Phase 2: pilot implementation

The pilot study was designed as a one-arm intervention study without a control group.

2.1.2.1. Participants

The pilot study was conducted at the Second Affiliated Hospital of Xi'an Jiaotong University. Nurses who were on duty from 20 October 2020 to 27 November 2020 were eligible for this study. Twenty-eight staff nurses in the hospital were recruited for the pilot study. The inclusion criteria of the pilot study were as follows: (1) nurses who scored 5 or above (moderate psychological distress) on the Kessler Psychological Distress scale (K6); (2) consent to participate in this study and signing a written informed consent; and (3) have taken care of patients during the pandemic. The exclusion criterion was severe mental disorders or imminent risk of suicide which was assessed by the K6 scale. Those scoring above 13 on the K6 scale were reassessed with the assistance of a psychiatrist to determine exclusion from the study (24).

2.1.2.2. Measures

The 6-item Kessler psychological distress scale (K6) (25), a simple measure to identify levels of distress, was used as the primary outcome measurement, which was measured at baseline and within 5 weeks post-intervention. The secondary outcomes included psychological flexibility, depressive and anxiety symptoms, post-traumatic stress disorder (PTSD) symptoms, and subjective psychological wellbeing, which were assessed by the

Comprehensive Assessment of ACT Process (CompACT) (26), the Patient Health Questionnaire (PHQ-9) (27), the 7-item Generalized Anxiety Disorder Scale (GAD-7) (28), the PTSD Checklist-Civilian Version (PCL-C) (29), and the Index of Wellbeing (IWB), respectively. All the measures used in the study have been translated and adapted into Chinese versions.

2.1.2.3. Intervention

The intervention used the adapted Chinese version of the SH+ package, including a package of pre-recorded exercises and an illustrated self-help manual with five parts: grounding, unhooking, acting on your value, being kind, and making room. The intervention was conducted through an online WeChat mini program for 5 weeks. Before the first SH+ intervention session, all participants were introduced to the contents and mode of intervention by the facilitators in a face-to-face session and reminded afterward in an online session. The five-session pre-recorded audio and video material was pushed via the WeChat mini program and also delivered to a WeChat group of 28 nurses in 5 weeks. The audio material imparted key information about stress management and guided the participants through individual exercises. To augment the course materials, an illustrated self-help course was presented to review all essential contents and concepts, and additional videos provided complementary material to aid understanding. A session reporting form was completed after each intervention session by the facilitators.

2.1.3. Phase 3: a process evaluation

A descriptive phenomenology approach was used for the process evaluation, in which a semi-structured interview was conducted among 28 participating nurses and facilitators to explore their experience and suggestions for the implementation of the program. Descriptive phenomenology, represented by Edmund Husserl, is an approach that emphasizes "To the things themselves" to depict the real world, to make people listen to phenomena more fully and truthfully, to stimulate people's feelings and observations of everyday experiences, and to increase the depth, width, and breadth of these experiences (30, 31). Thus, guided by the methodological approach, the researchers remain open and fully immersed in the research phenomenon throughout the entire research process in order to obtain an accurate description of the participant's experience in the program.

Two researchers (TT and ZY, H) conducted a semi-structured one-on-one telephone interview with 28 nurses, focusing on program perceptions, frequency of use, helpfulness, appropriateness, most valuable components, barriers to the adoption of the intervention, and recommendations for subsequent application. In addition, two facilitators were interviewed on the biggest challenges in training and supervising program implementation.

As the interviewees were divided into two groups: nurses and facilitators, the analysis of the qualitative data was carried out by two researchers who were each initially responsible for one group of data analysis, and they exchanged with each other to check the final result with key informants to ensure that the final presentation of the data accurately reflects the experience. In addition to this, the process of the data analysis and all significant statements were

examined and validated by an expert researcher (XL) to ensure the correctness of these processes, the consistency of the meanings, and the accuracy of the overall thematic map.

2.2. Data analysis

Descriptive statistics were used to describe the socio-demographic characteristics of the sample at baseline. The bivariate Pearson's correlations were tested between the average sum of scores on scales. The pre-and post-assessment measures were compared using a paired samples *t*-test to examine sensitivity to change and to analyze the general direction of changes before and after the intervention, after validating the assumptions of the paired samples *t*-test. Statistical analyses were carried out using SPSS 19.0.

A descriptive phenomenological approach using Colaizzi's seven-step data analysis within the phenomenological empirical framework was used for qualitative data. Colaizzi's unique seven-step process provides a rigorous analysis, with each step approaching data and widely used in disciplines such as health science (32, 33). The two researchers collected the data verbatim by transcribing the interviews in Chinese within 24 h after the interviews. The following seven-step approach was adopted: (1) Familiarity: they became familiar with the data by reading through all of the participant accounts several times. (2) Identifying significant statements: they identified all statements in the accounts that were directly related to participants' perspectives, program obstacles, and expectations. (3) Formulating meanings: they encoded significant statements and labeled them with the participants' keywords and phrases. (4) Clustering themes: they clustered the identified meanings into themes that are common to all accounts. (5) Developing an exhaustive description: they provided a detailed description of the resulting themes, incorporating all the themes generated in step 4. (6) Developing the basic structure: they identified and extracted similar ideas by repeatedly comparing similar themes and descriptions, and they built short and dense meaningful themes. (7) Seeking verification of the basic structure: they returned the basic structure declaration to all participants and asked if it reflected their experience.

2.3. Ethical conduct of research

The study was approved by the Ethics Committee of the Health Science Center at Xi'an Jiaotong University (No. 2020–1332). Written informed consent has been obtained from the participants.

3. Results

3.1. Phase 1: translation, adaptations, and cognitive interviews

3.1.1. Translation and adaptations

The intervention's fundamental structure, concepts, and techniques were culturally compatible and did not require significant modifications during the translation process. Participants from the nurses' group mentioned that most parts of

TABLE 1 Bernal framework of adaptations and examples of key adaptations.

Dimension	Operationalization	Examples of key adaptations*
Language	Emotional expression, verbal style	• All the materials were translated into simplified Mandarin. • The language was kept specifically colloquial rather than formal. Translations were conceptual rather than literal and word-to-word, to make the participants understand the underlying ideas and the concepts of the SH+.
Persons	Facilitators and the client – counselor relationship	• Facilitators were identified as acceptable delivery agents as they have ethnic, racial, and professional similarities with the client.
Metaphors	Symbols and concepts, sayings / proverbs	• The addition of the common Chinese proverb *"A journey of a thousand miles begins with a single step"* from <Tao Te Ching> elaborated on the importance of persistence. The metaphor was that the key to relieving distress is gradually accumulated from small to large, from little to too much via practicing. • The addition of Chinese idioms like *"A single spark can start a prairie fire"*– implied that the more we practice noticing our thoughts and feelings and refocusing on what we are doing, the better we will get. • Images embodying the nurse's avatar were used.
Content	Familiarity with local values, customs, traditions, and nursing context	• Replace expressions and scenarios that do not fit the Chinese condition,e.g., changing the "violence in the community" and images in exotic costume. • The addition of nursing contexts. • Examples of the stressors that were culturally and professionally suitable, e.g., conflicts between working and the family, occupational stresses during the COVID-19 were added.
Concepts	Constructs of theoretical model – how nurses' problems was perceived and communicated, including availability of locally used terms for theoretical concepts	• Personal concept (e.g., the values of *"prudence and professionalism"* and *"superb skill or technique"* according to traditional Chinese concept of pursuing excellence, and striving for perfection in one's life, and emphasizes rising in great vigor in one's work.) were added. • Social concept (e.g., *"The benevolent person always cares for others."*) were added.
Goals	Reflecting knowledge of values, culture, customs and traditions	• To encourage active participation of the nurses, the additional interview of the introduction to the content was added.
Methods	Methods and procedures to deliver the intervention	• Every part of the five sections of the self-help guide was given to nurses via WeChat each week, divided into five weeks to complete. Focused group interviews were organized before and one after the intervention. • Several ways of getting self-help activities, including audio, video and text online and off-line materials were given to nurses to choose.
Context	The culturally sensitive element of the context including nurses' distress during the pandemic, Chinese developmental stages, and availability of psychological supports for nurses	• All the SH+ materials were modified for integration into the Chinese context. • Some face-to-face SH+ sessions were abbreviated and integrated to match the context of general isolation and control in the hospital during the pandemic of the COVID-19.

the illustrated manual were comprehensible and acceptable, and helped reduce distress from working in the COVID-19 context. Nonetheless, subtle but essential adjustments were required in several domains. Key areas and examples of adaptations are given in Table 1.

In accordance with Bernal's framework, the translator sought to translate the conceptual equivalent of a phrase, as opposed to a literal translation, while keeping the target audience in mind. (i) *Language*: By avoiding long and convoluted sentences and specialized terminologies and jargon, the language was kept simple, plain, and concise. (ii) *Persons*: Facilitators providing the intervention implementation were perceived to be perfectly acceptable as delivery agents during COVID-19, given their role in the promotion of mental health for nurses. (iii) *Metaphors*: Several culturally relevant metaphors were employed to increase nurses' understanding and motivation and to reinforce the cultural context of the content. (iv) The *content* of the intervention material was adjusted to suit China's national conditions and customs. Similarly, the content was modified to use characters and scenarios based on the nursing context, including nursing

situations during COVID-19. For example, the distress that nurses faced was incorporated (Figure 1). (v) The *concepts* of society and culture were examined carefully and adapted. The Chinese nation inherits self-improvement, so the value concept of honesty and professional dedication was incorporated. At the same time, several mainstream social values in China, such as "kindness", "caring", and "harmony", were also added to the content. (vi) *Goals*: With many cultural and traditional differences in mind, a greater emphasis was placed on client-derived objectives as opposed to prescriptive goals. (vii) *Methods*: Some pictures were re-drawn to match the Chinese settings and culture. The delivery of the intervention was made compatible with the way nurses got used to it. (viii) *Context*: Adaptations to the context were necessary to ensure that the intervention could be implemented with the existing healthcare systems.

3.1.2. Cognitive interviews

In the cognitive interviews with clinical nurses, we found that further improvements were suggested by the end
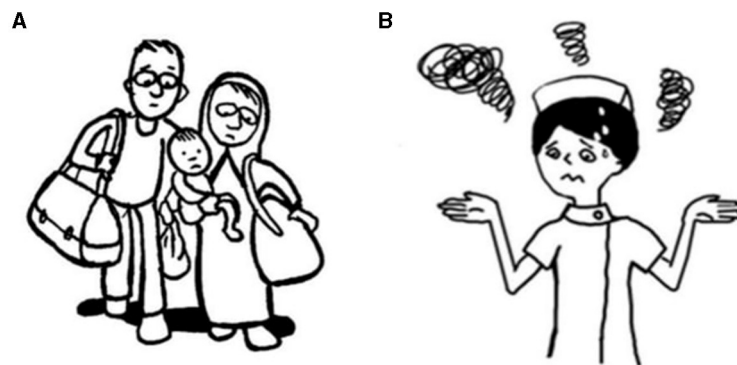
FIGURE 1
An example of the adaptation of characters in the content dimension. **(A)** is a family displaced from home in the original context in the original context and **(B)** is the adapted image of a nurse worrying about the change of daily life rhythm during the pandemic of COVID-19.

users. In terms of the self-help contents, it was generally understandable, although some nurses indicated that a few chapters and words were abstract and difficult to understand (e.g., "Imagine Gas flows in and around this object"). Furthermore, the subtitles also needed to be simplified and popularized to attract the attention of the participants. In addition, the brief introduction before each chapter was also highly recommended by nurses to meet their needs for a brief understanding of the learning purpose and then in-depth study and reading.

3.2. Phase 2: pilot implementation

3.2.1. Demographic characteristics at baseline

A total of 28 nurses with K6 scores above 5 were recruited for the pilot study. All of them were women who were aged between 24 and 54 years (34.48 ± 5.81). Close to nine-tenths (89%) were married, and 12 nurses had a bachelor's degree or higher education level. Further characteristics of the participants are presented in Table 2.

3.2.2. Correlations between measures

Correlations between outcome measures are shown in Table 3. All correlations were in the expected direction, although they did not always reach statistical significance in this small sample. For example, psychological distress demonstrated positive correlations with anxiety, depression, and post-traumatic stress disorder. Psychological flexibility was negatively correlated with anxiety, depression, and post-traumatic stress disorder, and positively correlated with subjective psychological wellbeing, such that higher psychological flexibility was, as expected, related to better outcomes.

3.2.3. Attendance and changes over time

We were unable to conduct post-intervention interviews with one participant (for personal reasons). Although the sample size was small, the changes in psychological stress, psychological flexibility, subjective psychological wellbeing, and depression after the 5-week intervention were statistically significant compared to the baseline level. We report our findings in Table 4. The K6 scores decreased by 27% from a mean of 10.19 ($M = 4.63$) to 7.44 ($M = 5.22$) (95% CI [-3.71, -1.78], $p < 0.001$). Psychological flexibility (CompACT) increased by 15% from 46.85 (14.86) to 53.74 (15.81) (95% CI [-12.35, -4.47], $p < 0.001$). The IWB scores increased from an average of 9.47 ($M = 2.73$) to 10.33 (2.42) (95% CI [0.07, 1.65], $p < 0.05$), an improvement of 9% in subjective psychological wellbeing. PHQ-9 scores decreased from 13.4 (5.1) to 4.2 (4.4) (95% CI [-2.78, -0.26], $p < 0.05$), reflecting an average improvement of 69% in depression.

3.3. Phase 3: process evaluation

The semi-structured interviews with 28 participants (27 completers and 1 non-completer) were conducted after the 5-week pilot implementation.

Overall, the intervention program ran smoothly under the guidance and supervision of the facilitators. The participants indicated that the interventions could effectively alleviate their distress in many aspects, such as helping them to engage in the present moment, being aware of difficult emotions and thoughts, and improving their sleep. The main challenge was ensuring adherence to the intervention and ensuring that the prescribed dose was received promptly. Participants' main suggestions were to post the manual online as short videos to make it easier and more efficient, to have a brief and lucid introduction before each part to obtain a quick understanding of the goal of the following segment, and to modify the interface of the mini program.

TABLE 2 Demographic characteristics of the pilot sample at pre-assessment (*n* = 28).

Characteristics	*n* (%)
Age (year)	34.48 (5.81)
Years of work (year)	11.74 (5.93)
Marital status	
Never married (single)	3 (11)
Married	25 (89)
Family income (per capita CNY)	
5000	5 (18)
5001–10000	14 (50)
10001–15000	6 (21)
15001	3 (11)
Education level	
Technical secondary school	2 (8)
Associate degree	14 (50)
Bachelor's degree or above	12 (42)
Professional title	
Nurse	1 (4)
Nurse practitioner	11 (39)
Nurse practitioner in charge/Supervisor nurse	14 (50)
Chief nurse practitioner or above	2 (7)
Position	
Nurse	17 (60)
Head nurse	10 (36)
Supervisor	1 (4)
Others	0

3.3.1. Participants' benefits from the program

In general, most of the participants considered the SH+ materials, such as the illustrated manual, the exercise audio, and the videos, very useful. The lessons and exercises in audio and short video formats were highly recommended. The participants indicated that they could comprehend and relate to the illustrations, and some reported that they had shared the illustrated manual with coworkers and patients in their unit.

Participants reported that SH+ assisted them in reducing distress, promoting relaxation, and enhancing their awareness and ability to be present. For example, one participant said:

> This program was very helpful. Especially the audio, a quiet relaxed state of mind occurred to me when I listened to instructions with music in the SH+ pack. There was a time when I was irritated and restless due to stress. I can't help getting annoyed with anybody around me. Then, I read the text and listened to the exercise audio on my telephone after work. I learned to live in the present, stop troublesome thoughts in my

mind, and concentrate on important things. Surprisingly, I felt much better, forgot the distress, and kept a tranquil mind after reading, listening, and practicing (Female participant, 37 years).

Many participants also indicated that the skills learned from the program could help them deal with difficult thoughts and feelings and improve their sleep. Just as one participant said:

> This WeChat mini program was a great help. My sleep improved a lot, which was the most significant change I can tell. I don't have enough time for myself in the daytime because of busy clinical work. So, I usually used the applet before going to bed, which was relaxing. After listening to it, I can quickly fall asleep. This was the most obvious effect for me. By the way, I thought highly of your applet design because the audio can still play when the phone page was off which means there was no need to turn off the audio while I was almost falling asleep (Female participant, 36 years).

Apart from that, being aware of and re-recognizing distress, including physical symptoms and emotional responses to psychological distress, was a change identified by participants, as illustrated by the following quotes:

> After learning about this program, I realized that a certain amount of stress might cause some physical problems, including gastrointestinal reactions. When I was there (in the COVID-19 isolation region), my stomachache was so severe that I couldn't sleep at night. I had been suspected of having stomach problems and taking omeprazole all the time to kill the pain. After coming back, I had a gastroscopy immediately and it turned out fine. Now, I believe that it was stress and stomach cramps (Male participant, 36 years).

> I used to believe that blue mood or distress should be paid attention to only when it reaches a certain high level and becomes unbearable. However, after learning about this program, I found that some mild feelings and symptoms, such as irritability, sadness, inattention, etc., may be caused by some psychological distress, which was quite helpful for me to have a new understanding of distress. People tend to only notice mental health when they have symptoms or even illnesses, such as depression. The key is to notice when we don't (Female participant, 37 years).

3.3.2. The difficulties of adhering to the program

Adherence to the self-help program was mentioned by most participants. Some participants stated that they tended to forget to practice the content or to do the exercises due to their intense and highly stressed clinical work, or distractions from social media on cell phones (e.g., WeChat, TikTok, Kuaishou, and RED). Several participants mentioned that it was difficult to persist with a 5-week course that indicated further adaptations, so the program fitted better with the busy lives of practicing nurses.

Changes in applet pushing strategies, such as increasing the push frequency of the mini program and adjusting the pushing

TABLE 3 Correlations between measures at baseline ($n = 28$).

	Distress (K6)	Psychological flexibility (CompACT)	Wellbeing (IWB)	Anxiety (GAD-7)	Depression (PHQ-9)	PTSD (PCL-C)
Distress (K6)	1					
Psychological flexibility (CompACT)	−0.49**	1				
Wellbeing (IWB)	−0.82***	0.53**	1			
Anxiety (GAD-7)	0.73***	−0.31	−0.80***	1		
Depression (PHQ-9)	0.81***	−0.57**	−0.87***	0.86***	1	
PTSD (PCL-C)	0.86***	−0.54**	−0.83***	0.69***	0.83***	1

p, significance value; *p < 0.05, **p < 0.01, ***p < 0.001; n, number of subjects; k6, Kessler Psychological Distress Scale; CompACT, Comprehensive assessment of ACT process; IWB, Index of Well-Being; GAD-7, Generalized Anxiety Disorder; PHQ-9, Patient Health Questionnaire; PCL-C, PTSD Checklist – Civilian Version; PTSD, Post Traumatic Stress Disorder.

TABLE 4 Comparison of pre-and post-assessment measures ($n = 27$).

Outcome	Pre-assessment, Mean (SD)	Post-assessment, Mean (SD)	Mean difference	Percent change (%)	95% CI for Mean difference	p
Distress (K6)	10.19 (4.63)	7.44 (5.22)	−2.74	−26.89	−3.71 to −1.78	<0.001
Psychological flexibility (CompACT)	46.85 (14.86)	53.74 (15.81)	6.89	14.71	−12.35 to −4.47	<0.001
Wellbeing (IWB)	9.47 (2.73)	10.33 (2.42)	0.86	9.08	0.07 to 1.65	<0.05
Anxiety (GAD-7)	7.19 (5.38)	6.48 (5.24)	−0.70	−9.74	−1.90 to 0.49	0.242
Depression (PHQ-9)	9.15 (6.44)	7.63 (6.75)	−1.52	−16.61	−2.78 to −0.26	<0.05
PTSD (PCL-C)	40.30 (14.92)	37.19 (15.92)	−3.11	−7.72	−6.73 to 0.51	0.090

n, number of subjects; SD, standard deviation; CI, confidence interval; p, significance value; k6, Kessler Psychological Distress Scale; CompACT, Comprehensive assessment of ACT process; IWB, Index of Well-Being; GAD-7, Generalized Anxiety Disorder; PHQ-9, Patient Health Questionnaire; PCL-C, PTSD Checklist – Civilian Version; PTSD, Post Traumatic Stress Disorder.

time to the timetable of nurses, were proposed. For example, a head nurse said:

> I think learning the program through WeChat was the most convenient way. My distress and tension were eased while learning this applet, but most of the time, it was difficult to make time for practicing continuously. Maybe you can push the content a few times more for reminding. And it also could be helpful for learning when we receive lessons in our spare time, such as during noon break, off-work time, or time before bed (Female participant, 40 years).

Many participants assumed that overloaded information on a cellphone was not conducive to concentrating and insisted on learning the program. Learning in a variety of ways, such as brochures and sharing within groups, was identified by facilitators as illustrated by the following quote:

> "There are tons of mini-programs, public accounts, and information on the WeChat platform, which is hard for participants to focus on one on their own initiative or to adhere to it. According to this circumstance, they tended to pay attention to information that appears in front of them directly. It was suggested that several ways of learning to emphasize and go over the lesson, such as handing out simple brochures or conducting small group sharing regularly might be helpful." (Female intervention facilitator, 26 years).

A few participants who did not complete the whole package of lessons in 5 weeks stated that they lost interest after the initial session.

> "I tried the exercise at the beginning, but it didn't attract me afterward. As for me, there was too much theoretical staff in the program making it obscure and abstract. I prefer more practical things or tools to help me out of difficult circumstances or problems specifically, such as relationship problems, relentlessness, anxiety, gloomy mood, or insomnia. A problem-based system of instruction and exercise would be much better." (Female participant, 32 years).

4. Discussion

To the best of our knowledge, this is the first study in translation, adaptation, and initial evaluation of SH+ in China. Three main conclusions could be drawn from our findings. The series of methods we adopted were very necessary for the cultural adaptation of the entire set of interventions. Through expert group interviews and user testing, we made many adjustments to the language, semantics, context, and pictures in the guide based on expert feedback, making the guide more in line with Chinese culture and economic conditions. Compared to the traditional psychological intervention, the self-help intervention that relied

primarily on pre-recorded materials was viewed as a significant advantage of the SH+ format in terms of fidelity and scalability, making stress management more accessible and allowing it to be applied to a large population without the need for psychological professionals. In the intervention period, many participants were not familiar with the content and operation methods, and some of them tended to miss part of the content due to work tension and other personal reasons. Other studies have found that active guidance by facilitators for the intervention was associated with larger effect sizes than unguided self-help interventions (19), and we feel some facilitation by peers could improve adherence in our context as well.

We found that it was necessary to make the program content more interesting and appealing by adding some scenes or stories close to life to grab the readers' continuous attention. In terms of intervention presentation, we found that short videos based on the WeChat program were a convenient and acceptable format. Short videos can be easily learned with full concentration in a limited amount of time. In addition, many nurses suggested that it was better to make the interface of the program classified by problems and symptoms, rather than by topic or chapter so that they could use the program according to their needs and it would be easier to maintain their interests and problem-solving capacity.

Importantly, the pilot showed promising results for SH+, which were consistent with studies of SH+ in other countries in the prevention and treatment of common mental disorders in refugees and asylum seekers (34–36). The cognitive interviews indicated that the adjusted guidelines were understandable, acceptable, and relevant. Our findings were consistent with the findings of related studies that mindfulness and acceptance and commitment therapy-based interventions are effective in reducing psychological distress and depression, as well as enhancing psychological flexibility and subjective psychological wellbeing among nurses (37–39). The change in anxiety and post-traumatic stress disorder was not statistically significant, which needs further evaluation through a sufficiently powered randomized controlled trial. These preliminary results suggest that the intervention program has a potentially positive effect on reducing the psychological distress of nurses working during COVID-19.

The main challenges we faced were poor adherence to the 5-week intervention cycle and the difficulty in producing the WeChat-based mini program. It may be that nurses were so occupied with the fast-paced, high-intensity, and stressful clinical nursing work, coupled with busy family life, that they forgot or missed the regular program lessons occasionally, which required facilitators to remind them constantly and push them repeatedly. In addition, competing information on various mobile platforms hindered our intervention from being easily used and made it difficult to stick to one program. Another challenge that needs to be considered was that most young people are immersed in short and quick information (especially short videos). Therefore, adapting the theoretical knowledge and skills into simple and short videos or texts is likely to be more attractive. Further adaptations catering to the specific context of nurses with busy professional and personal lives can enhance the value of the intervention.

Finally, a fully powered randomized controlled trial is required and is presently being planned for a more rigorous evaluation of the potential benefits of SH+ for Chinese clinical nurses.

5. Limitations

The following limitations must be considered when reading these conclusions. First, the evaluation of pre- and post-intervention scores in the pilot study was conducted with a limited sample and no control group. These results should not be interpreted as an indication of the effectiveness of the intervention but rather as an indication of the prospective feasibility and appropriateness of the intervention and the assessment measures. Future randomized controlled studies should be conducted to explore these trends in greater depth. Second, the analysis of the qualitative process evaluation data was initially conducted by one person, increasing the possibility of results that rely on the researcher's intuition and interpretative abilities and lack a broader and more complex understanding of the phenomenon. Finally, the main purpose of the qualitative study was mainly to explore the feasibility of the initial intervention program and the facilitators and barriers to the pre-experimental process, so the sample was drawn from a single source; as a result, the findings could not be generalized to a larger population.

6. Conclusion

Notwithstanding these limitations, our findings were promising and indicated that the translated and adapted Chinese version of SH+ was applicable and feasible to alleviate nurses' psychological distress in the Chinese cultural context. Cost-effectiveness is likely to be achieved when delivering an innovative, scalable psychological self-help intervention to large groups of participants in challenging settings. A randomized controlled trial as a more rigorous evaluation is also recommended to validate the effectiveness of the self-help intervention.

Data availability statement

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

Ethics statement

The studies involving human participants were reviewed and approved by the Ethics Committee of the Health Science Center at Xi'an Jiaotong University (No. 2020–1332). The patients/participants provided their written informed consent to participate in this study.

Author contributions

LY and TT designed the study. XL and LY translated the materials into Chinese language. TT and ZH were responsible for the recruitment of participants. TT wrote the first draft. DW, AR, and XL critically review the article and gave their input. TT, LY, ZH, JS, YJ, and QG participated in the study design, data collection, and analysis. All authors revised and approved for submission.

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Conflict of interest

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

Publisher's note

Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyt.2023.1168117/full#supplementary-material

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Check for updates

Psychological resilience matters in the relationship between the decline in economic status and adults' depression half a year after the outbreak of the COVID-19 pandemic

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Background/objective: The outbreak of COVID-19 in China since 2019 has had a significant impact on the mental health of people in Hubei Province during the three-year pandemic period. Therefore, studying the prevalence of depression among the population of Hubei Province since the pandemic is of great significance.

Methods: Based on opportunity and stress theory, we collected provincial-level data from Hubei ($N = 3{,}285$) to examine the impact of declining economic status on depressive symptoms and to investigate the moderating effect of psychological resilience during the period of economic adjustment.

Results: We used propensity score matching to estimate the treatment effect of economic status decline on depression severity and confirmed the moderating effect of psychological resilience. We found that the more that an individual's economic status declines, the more severe that his or her depressive symptoms become. Specifically, each unit decrease in economic status is associated with an increase of approximately 0.117 units in depression level. In addition, our results indicated that psychological resilience significantly moderated the relationship between economic decline and depression (-0.184^*).

Conclusions and implications: Our study confirms the role of economic status in depressive symptoms. Compared with traditional research on the relationship between economic status and mental illness, this paper expands the research regarding the two in the context of a major public health emergency. Furthermore, we suggest ways to improve people's mental health following the pandemic.

KEYWORDS

psychological resilience, economic status, depression, COVID-19, propensity score matching (PSM)

1. Introduction

As the most extensive global pandemic encountered by human beings in the past 100 years, the COVID-19 pandemic has not only caused damage to people' bodies but also greatly affected their mental health. China is one of the most severely affected countries in the world by the COVID-19 pandemic. In December 2019, a new coronavirus was reported in Wuhan, Hubei Province, China, and over the next 3 years, the pandemic spread rapidly across the globe, threatening the lives and health of people worldwide. The closer to the center of the crisis, the more people's mental state is negatively affected by the social crisis (1). People are more prone to negative emotions such as loneliness, depression and anxiety. Depression is an affective disorder and is regarded as a mental disorder with depressed mood, hopelessness, and helplessness as the main symptoms (2). The factors affecting depression include individual factors, social factors, mental factors, and so on. Sudden major public health events have a significant negative impact on depression. The earlier study of the COVID-19 pandemic showed that the COVID-19 pandemic and the lockdown and quarantine policy resulted in a higher prevalence of depression and lower levels of mental health among the Chinese. A comparison with the results of previous cross-sectional studies can conclude that the level of mental health of Chinese people is deteriorating (3).

Today, although National Health Commission of the People's Republic of China Announcement announced that the COVID-19 pandemic is almost over (4), the mental damage it caused remains, and people's mental status has not improved significantly (5). One explanation for such a high prevalence of depression may be that the reduction in income and economy during the pandemic increased the social stress of individuals. According to the opportunity and stress hypothesis in social stress theory, people with lower economic status will experience more stress in their lives with limited opportunities to relieve stress. Thus they are more likely to suffer from mental disorders such as depression (6). During the pandemic, work stoppage, unemployment, and income disruption led to a decrease in the economic status of people in Hubei Province and increased social pressure, which led to increased rates of depression.

Given the wide range of mental health issues affected by COVID-19, it is important to identify protective factors for depression. Current studies have shown that protective factors for depression in the COVID-19 pandemic include social isolation, being female, living in rural areas, talking to parents, and hobbies (7). In addition to that, other studies have suggested that psychological resilience is also a protective factor for depression. According to the Richardson model, mental resilience can interact with external or internal risk factors (8), which means that it can protect individuals from negative events, especially disasters or health crises and reduce the risk of mental illness (8, 9).

Although the COVID-19 pandemic has had a broad impact on society, the mental status of the affected people still varies greatly, and the degree of depression varies greatly between different groups, which we are very concerned about. We sought to explore the relationship between post-pandemic changes in economic status and depression and to demonstrate the protective role of psychological resilience against depression during major public health emergencies.

2. Literature review

2.1. Depression under public health emergencies and its influencing factors

Sudden public health events will not only affect people's physical health, but also have a certain negative impact on people's psychology. Increased work stress, work stoppage, income disruption and financial strain have caused serious mental distress to the public, exacerbating symptoms such as depression (10). Numerous studies have shown that the COVID-19 pandemic is severely damaging people's physical as well as mental health (10–12). The World Health Organization estimates that the pandemic has led to a 25%–27% increase in the prevalence of depression worldwide (13). Studies from Israel, the United States and other countries found that the general level of depression increased significantly after the pandemic, especially the depression level of the general population in the United States increased from 8.5% to 27.8% (14, 15), further demonstrated the impact of the COVID-19 pandemic on individual mental health. Among people affected by the pandemic, a study involving several different countries in Europe, Asia, and North America found that the incidence of depressive symptoms ranged from 14.6% to 48% (14). Another study also showed that the prevalence of depression in the Asia-Pacific region reached 34% (10). Of these, China, the first country to be hit by the pandemic, has a 29% prevalence of depression (16). Since the outbreak of COVID-19, all sectors of Chinese society have been severely affected, with an increase in the prevalence of depression among frontline healthcare workers, patients with new crowns, and the general public. A study of healthcare workers in Wuhan, China, found that 50% of participants experienced depression and more severe symptoms among first-line nurses fighting the virus (17). In addition, family members of frontline health workers were also affected: their depression prevalence was 12.2%, higher than that of the general Chinese population during the non-pandemic period (18). Moreover, the prevalence of depression among COVID-19 patients has increased due to the dual stress of mental pain and mental fear. One study found that 18.6% of mildly infected patients in China were depressed. Moreover, a survey of general residents who were quarantined at home due to the pandemic was also conducted and found that the prevalence of depression was significantly higher in the quarantined population in Shenzhen (6.21%) compared to the general population in Chongqing (3.7%) who were not quarantined (19). Hubei Province in China was the first region to be affected by the pandemic, and the people of Hubei suffered far more mental stress than other regions. A survey conducted during the COVID-19 pandemic showed that depression symptoms were most severe in Wuhan, Hubei Province, compared to the rest of the country, followed by the rest of the province (20).

The onset of depression may be influenced by a range of factors, including physical factors, personal characteristics, social factors, mental factors, and geographic factors. In terms of physical factors, sleep health is one of important conditions affecting depression, and the COVID-19 pandemic has been demonstrated to lead to deterioration in people's sleep quality, as evidenced by difficulty falling asleep at night and increased daytime nap time (21). Previous studies have shown that depression occurring in the context of a major life event is associated with poorer sleep quality (e.g., difficulty falling asleep, daytime sleepiness, awakening from sleep, etc.) (22).

Demographic characteristics are also one of the avenues that many scholars have used to explore the impact of the pandemic on depression. Several studies have shown that gender, age, marriage, income, and educational attainment also influence the prevalence of depression: women, young adults, unmarried, those with less than junior high school education, and those with lower economic status are more likely to be depressed (10, 20, 23, 24). In terms of social factors, sudden major events and social support can affect the prevalence of depression. In addition to the negative impact of the COVID-19 pandemic itself on depression, the use of social media is also an important influencing factor. There are two different views on the role of social media in the existing research, one of which is that the use of social media is a protective factor against depression for people in the pandemic and is an important source of social support. People obtain health information and emotional support from peers from social media, especially WeChat and thus effectively reduce the negative emotions brought by the pandemic (12). However, another survey from the United States suggests that people who did not have mental problems prior to the outbreak may have used social media in a counterproductive manner, with searching and viewing online searches or social media posts about the coronavirus, reports of significant changes in personal lives due to the outbreak, and perceptions that the virus posed a threat to the U.S. economy, personal health, or finances being significant factors in people's distress (25). In terms of mental factors, long-term isolation and blockade policies can also have a negative effect on people's mental situation, with public health restrictions leading to increased loneliness (26). Loneliness is an important contributor to depression (27). As the duration of the pandemic increases, people also gradually lose hope in ending the pandemic, and short-term concerns and fears are transformed into long-term mental emotions, and in these pandemics, concerns about personal and family health, as well as uncertainty about the future, may lead to depression (28). Geography also plays an important role in the increase in the prevalence of depression, with some studies suggesting that during public health emergencies, the psychological state of people in different regions may change from region to region, known as the "ripples effect." That is, the closer an individual is to the center of the crisis, the higher the awareness of risk and negative emotions about the event (1). This has been verified by studies of the effects of the Wenchuan and Yushu earthquakes on the mental status of nearby residents. Hubei Province, the epicenter of the COVID-19 pandemic in China, was the obvious starting point for the "ripple effect." However, it has also been suggested that there is no significant difference in depression prevalence between regions (10), which differs from previous studies.

2.2. Decline in economic status as an antecedent of depression

An investigation during the pandemic showed that income disruption and financial stress were risk factors for the prevalence of depression among countries in the Asia-Pacific region (10). The COVID-19 pandemic added uncertainty to the already unstable economic resources of low-income households (29). This makes their survival more difficult. The economic status of people in several countries have been affected globally: a study of the economic status of a group of people with underlying diseases in Bangladesh found

that 46.2% of participants reported experiencing economic hardship during the COVID-19 pandemic and 12.3% lost their jobs (30); the study from Argentina also showed that more than half of the participants reported economic problems. Those who lost their jobs during the pandemic often faced financial problems (31). In China, 33.7% of households in Hebei Province experienced a significant decrease in income, while only 0.4% experienced a significant increase in income during the outbreak (32). There is an important difference between the two. Thus, decline in economic status occurs in several countries, and this has become one of the important factors contributing to the increase in individual depression levels after the pandemic. Previous studies have examined the relationship between social stress and mental illness. In 1989, Pearlin (33) proposed the social stress theory, which consists of three components: stressors, stress mediators, and stress responses. In subsequent studies, this model has been supplemented and developed by many researchers. Both Thoits and Aneshensel emphasize the importance of social status in terms of social and psychological stress (34, 35). In 2005, Christopher G. Hudson proposed the opportunity and stress hypothesis, which suggests that economic status is strongly negatively associated with mental illness, implying that lower economic status tends to increase individuals' exposure to social stressors, thereby increasing their likelihood of developing mental problems (6). In conjunction with the research theme of this paper, we consider the pandemic and the negative effects of the pandemic as a source of social stress (36). We select the opportunity and stress hypothesis as the theoretical basis for exploring the association between economic status and mental illness. Sudden public health crises will, to a certain extent, affect people's economic status. For example, once the economic status of a low-income family declines, the family members will inevitably be exposed to more social pressure, and they will be more prone to worry about their future lives, which will lead to an increase in the prevalence of depression. Therefore, we put forward the following hypothesis.

> *H1:* The greater the decline in economic status is, the greater the negative impact is on depression.

2.3. The moderation of psychological resilience in depression

Psychological resilience has long been one of the key concepts in studying the psychological impact of public health crises on individuals. In most of the studies related to COVID-19, psychological resilience has been defined as a psychological trait with positive psychological qualities that enable individuals to effectively cope with stressful situations (8, 18, 37–39). Psychological resilience varies enormously across individuals, and people with different levels of psychological resilience tend to have different levels of resilience and ability to recover from stressful events. It has been shown that psychological resilience is a protective factor against anxiety, depression, and stress (40), moderates the negative effects of risk factors (41), and has a significant negative predictive effect on depression in particular (18, 42). This is corroborated by a study from China: psychological resilience moderated the negative effects of negative life events on depressive symptoms after an earthquake (20).

People with lower psychological resilience have poorer mental health outcomes in disasters (18), whereas the higher the psychological resilience, the greater the person's ability to resist depression and anxiety, and the less likely they are to experience elevated levels of depression in the face of an unexpected public crisis event. There have been numerous articles explaining the role of psychological resilience in the pandemic. Garmezy (41) proposed psychological resilience was mentioned in the study as a protective factor that has an important role in regulating the negative effects of risk factors. This is supported by a study from China in which psychological resilience moderated the negative effects of post-earthquake negative life events on depressive symptoms (20). Other studies have also shown that psychological resilience has a significant negative predictive effect on depression (18, 42). People with lower psychological resilience have poorer mental health outcomes in disasters (18). This may be due to the constant stress and sense of crisis caused by the outbreak. Examples include prolonged isolation, fear of infection, despair, fatigue, lack of resources, lack of information, economic loss, and shame (43). Richardson's model further developed the protective model of psychological resilience, it assumed that protective factors (e.g., the character, trait, or situational premise of resiliency) and risk factors (e.g., contingencies, negative life events, and adversity, etc.) interact with each other in a balanced manner (44). During the COVID-19 pandemic, the risk factors increase significantly, and more protective factors are needed to balance them and maintain a state of mental equilibrium (8). The subject of this paper is the relationship between the decline in economic status and individual depression, so following the above theory, we consider the decline in economic status after the pandemic as a negative event and depression as a negative effect, and for psychological resilience, we will continue to follow the previous literature and use it to moderate the relationship between the two variables, exploring whether individuals with different psychological resilience will differ in the degree of depression. Therefore, we propose the following hypothesis:

> *H2:* Psychological resilience significantly moderates the relationship between the decline of SES and depression.

In January 2020, Wuhan declared a "city closure" policy, which lasted until April of the same year. During this period, the spread of the unknown virus and the increase in the number of deaths brought great psychological pressure to the people of Wuhan, and it is crucial to study the psychological conditions of the people in Hubei Province. Currently, research on the psychological condition of the people in Hubei Province after the outbreak of COVID-19 pandemic mainly focuses on exploring the psychological state of the people during the pandemic. Less attention has been paid to depression after the end of the pandemic. In addition, due to differences in geographic location and economic structure, foreign studies may not be fully adapted to the domestic environment. Therefore, based on the above research background, this study will focus on the depressive state of people in Hubei Province after the pandemic, and use the opportunity and stress hypothesis and Richardson model to explore the effects of changes in economic status on depression under the regulation of psychological elasticity. It will provide a reference value for the future response to the mental health problems caused by sudden public health crisis events.

3. Methods

3.1. Sampling

During the period of the COVID-19 outbreak, from January 23 to April 8, Wuhan and other cities in Hubei Province were subjected to strict lockdown measures. This study draws on original research conducted by the School of Sociology, Central China Normal University, in June 2020, which coincided with a critical period of psychological adjustment for the residents of Hubei. Data were gathered through an online questionnaire administered during the lockdown period. This survey aimed to grasp the psychological and behavioral status of the population, their work and living conditions, and thus facilitate a thorough analysis of the various manifestations of post-epidemic syndrome and effectively promote the restoration of economic and social order. This survey encompassed various modules on mental health, family relationships and family life, social interactions and economic behavior, and online behavior and social mindset. In order to prevent participants from facing overly lengthy questionnaires, participants were asked to answer the basic module and were randomly assigned to one of the four above thematic modules. A total of 3,285 valid participants older than 16 responded to the thematic modules of depression. The sample comprised 54.43% males; the average age was 32.40 years old, and 34.58% lived in Wuhan City. The research received ethical approval from the ethics committee of the School of Sociology at Central China Normal University in China.

We utilized the trade union platform of Hubei to distribute electronic questionnaires to a target population of 14 million workers throughout the entire province. In order to minimize sampling bias, our initial focus was on workers aged 16 and above who resided in cities at the county level or higher within Hubei province. To ensure data quality, we implemented a filtering prompt in the first questionnaire item. We excluded responses with a duration of less than 5 min where the distribution of response times shows a noticeable truncation at the 5-min mark, and those that displayed logical inconsistencies. To reduce duplicate submissions, we employed measures such as IP address identification and account restrictions. Finally, to achieve a representative sample, we applied appropriate weighting techniques using population statistics provided by the Hubei Provincial Federation of Trade Unions.

3.2. Measurements

Depression level: We took depression as our dependent variable and adopted the World Health Organization Five-item Well-Being Index (WHO-5) to measure depression symptoms. The WHO-5 scale has adequate validity both as a screening tool for depression and as a measure of the severity of depression severity (45, 46). Participants were asked to rate their status from all the time (score 0) to never (score 5) over the previous 4 weeks, and the total score could range from 0 to 25. The content of the index is positive, with a total score of more than 12 defined as poor mental well-being. The WHO-5 has been found to have adequate validity and good construct validity in Chinese populations (47). In this survey, the overall Cronbach's coefficient of the scale was 0.964.

The decline in economic status: According to Howell and Howell (48), we adopted decreased income to measure economic status decline as the independent variable. The participants were asked to what extent COVID-19 inflected their family income in the survey. We based the response and classified the participants into two mutually exclusive types: the economic status decrease group (coded as 1) and the control group (economic status increased or remained the same, coded as 0).

Resilience: Resilience as our moderator was measured using the Connor-Davidson Resilience scale (CD-RISC). The CD-RISC comprises three dimensions and 25 items, each rated on a 5-point scale (1–5), with higher scores reflecting greater resilience (49). The Chinese version of the CD-RISC showed good reliability and validity in the Chinese population (50). In this survey, Cronbach's α was 0.986.

Covariates: Based on the literature review, we found potentially available explanatory factors for depression perception. At the individual level, we included several demographic factors (age, gender, education, party, household registration, job status, social status), physical factor (sleep health), psychological factors (interpersonal relationships, the strictness of lockdown), and social factors (critical negative events, exposure to pandemic information, and negative encounters during pandemic). Table 1 shows the meanings and measurements of the above factors.

3.3. Analytical strategy

We followed a two-step analytical strategy to empirically examine the association between the decrease group and the control group. In the first step, we performed a propensity score analysis to control for potential selection bias. We used a developed package—teffects psmatch—available in Stata software, version 17.0, to estimate the average treatment effect on the treated (ATET). The propensity score matching method utilizes terminology commonly used in experimental studies, such as treatment group and control group. The underlying logic of the propensity score matching method is rooted in the influential counterfactual framework developed by Rubin (51). In this framework, the propensity score represents the conditional probability of receiving treatment given the observed covariates. By estimating propensity scores and ensuring that the treated and control groups have similar scores, the observed covariates are effectively controlled for. Consequently, any differences between the treatment and control groups can be attributed to the receipt of treatment, rather than to the influence of observed covariates. This adjustment enables better control for confounding factors. We adopted a 1:1 matching strategy with replacement, estimated the *p*-score by a logit model, and set the default caliper (52). This is a relatively balanced parameter setting that neither overly restricts the sample size nor excessively loosens it, ensuring a balance between sample size and representativeness. Only the sample in common support was matched, which ensured that the propensity score values of the treatment group and control group have overlapping ranges. In addition, we analyzed the sensitivity of matching based on Imbens (53), examining the impact of confounding factors on the treatment variable and the outcome variable. We also conducted a heterogeneity analysis, investigating the extent of the impact within different subgroups based on our points. In the second step, we estimated an ordinary least-squares linear regression model and a multiple linear regression using

income decrease as the key response. The goal is to understand the different effects of income decrease on the probability of depression levels among citizens after adjusting for a set of 17 covariables. Model 1 was our baseline model. Based on Model 1, Model 2 added demographic covariates, and Model 3 added all covariates. The matched columns show the compared results of estimates after applying sample weights depending on the number of matched times generated during matching. Finally, we checked the possibility of resilience as a moderator of the model.

4. Results

4.1. Descriptive statistics

Descriptive statistics are presented in Table 2 to summarize the characteristics of the sample and examine the distributions of variables. Overall, 60.49% of participants' economic status decreased during the lockdown, whereas 39.51% increased or remained the same. The average resilience level was approximately 3.38. From the total column in Table 1, 32.24% of the sample had poor mental well-being; the average education years numbered 14.02; 27.21% were party members; 28.01% were Wuhan citizens in our sample, and 53.24% lived in the countryside far from the city center; and 7.82% did not have jobs the 3 months before our survey. Perceived social status was approximately middle (5.58 of 10). Only 5.05% of respondents did not have conflicts with pandemic protection personnel; almost half of them thought the lockdown policy was very strict, and 64.81% did not have a chance to go out. A total of 6.64% had COVID-19 cases in their family. On average, our respondents spent 2.46 h searching for or reading COVID information; each citizen encountered 1.34 negative incidents.

Table 1 also compares the characteristics between the treatment group (decrease group) and the control group. The mean depression level in the treatment group was higher than that in the control group, both before and after matching. Before matching, the likelihood of being in the decreased group was greater for participants who lived in urban areas, quarreled frequently with family members, and had COVID-19 cases in their family compared with those in the control group. The likelihood of being in the decreased group was smaller for participants who were party members living in the countryside compared with those in the control group. On average, participants in the control group felt less depression, had healthier sleep, spent less time reading pandemic information, and encountered fewer negative events in life.

4.2. Multivariate results

Before estimating, we adopted the methodology of multiple imputations for missing values of the variable of social status, which were replaced by draws from the predictive distribution (54). We randomly generated several imputation values relying on the Bayesian model and data fit and used the mean imputation value as the unique value for matching and further analysis. Then, we checked the quality of propensity score matching according to the procedures. We conducted paired t-tests with the propensity-score-matched groups. The results showed that the difference between groups was not

TABLE 1 Covariate meanings and measurements.

Covariates	Meanings and measurements
Demographic factors	
Age	Age as of 2022.
Gender	Male or female.
Education	The number of years of education a person completed.
Party	Whether one was a Communist Party member.
Household registration	It was categorized into 4 levels (1 = countryside, 2 = town, 3 = rural–urban fringe, 4 = urban areas) depending on the distance to city center.
Job status	Job status in the previous three months: 1 = Had job, 0 = No job.
Social status	Self-report of perceived social status with 10 grades, from low (1) to high (10). Social status refers to a person's position or rank within a social hierarchy or structure.
Physical factors	
Sleep health	The product of sleep time and sleep quality, and sleep quality was rated by participants from very bad (1) to very good (4).
Psychological factors	
Interpersonal relationship (with family)	The frequency of quarrels with children/spouse during the pandemic.
Interpersonal relationship (with pandemic prevention personnel)	Whether one has conflicts with pandemic prevention personnel.
Subjective feelings about strictness	Subjective feelings about lockdown policy.
Frequency of going out	Objective strictness of lockdown policy.
Social factors	
Critical negative events	Whether one has COVID-19 cases (close-contact cases, suspected cases, confirmed cases or death cases) in the family: 1 = Had cases, 0 = No cases.
Exposure to pandemic information	The average amount of time participants have spent searching for and reading pandemic information since the lockdown.
Encounters with Hubei citizens	The number of following things that participants have encountered: (a) seen comments on the internet or in chat groups that discriminate against or curse Hubei/Wuhan citizens; (b) refusal to be accepted by local government and communities when returning home during the Spring Festival; (c) being excluded when traveling, such as not being allowed to stay at hotels; (d) being ostracized and attacked by relatives and neighbors when returning home during the Spring Festival; (e) being rejected by one's boss because of being Wuhan/Hubei citizens when returning to work; (f) being shunned and ostracized by colleagues because of being Wuhan/Hubei citizens after returning to work.
Fixed: city	An ordered categorical variable in terms of the distance to Wuhan, including Wuhan City, other cities in Hubei Province, Hubei/Anhui/Henan Provinces near Hubei, or other provinces in China.

significant after matching, excluding the treatment variable (see the compared p values in Table 2). We also reported the variables' normalized bias, according to which all of them in matched groups numbered less than 10%, and most t-tests did not reject the null hypothesis that there was no systematic difference between the treatment group and the control group (Table 3). In addition, only 25 observations were off support, meaning that we lost a few samples during matching.

Table 4 provides the results of matching. The level of depression in the treatment group was 0.247 higher than that in the control group on average, indicating that decreased income could increase depression levels by 0.247 on average ($p = 0.000$, SD = 0.068). Sensitivity analysis showed that no variable was located near the contour. This finding indicates that there were no unobservable effects on the outcome variable and the treatment variable, decreasing the treatment by half. Thus, *H1* was supported. Table 4 also shows the heterogeneity results of matching. Compared to citizens staying in

Hubei during the lockdown period, decreased economic status was more likely to result in depression of Hubei citizens staying outside of Hubei during the lockdown period ($\beta_{\text{non-Hubei}} = 0.204^*$ vs. $\beta_{\text{Hubei}} = 0.163^*$). Compared with people in rural areas, people living in urban areas ($\beta_{\text{urban}} = 0.379^{***}$ vs. $\beta_{\text{rural}} = 0.208^{**}$) experienced less depression due to economic status decline. Additionally, individuals who had COVID-19 cases (close-contact cases, suspected cases, confirmed cases or death cases) in their families were more likely to experience depression when there was a decline in economic status ($\beta_{\text{cases}} = 0.278^*$ vs. $\beta_{\text{no-cases}} = 0.251^{***}$).

We tested for homoskedasticity with the Breusch–Pagan/Cook–Weisberg test, which indicated OLS robust estimations in all cases except matched Model 1 (matched) to control for heteroskedasticity. We checked for potential multicollinearity issues by computing the variance inflation factor (VIF). The results for the mean VIF ranged between 1.00 and 1.20, and all individual VIFs are far less than 1.57, far less than values that would suggest any multicollinearity issue

TABLE 2 Descriptive characteristics of participants, according to income decline, before and after propensity score matching.

	Total		Unmatched					Matched				
			1 = decrease		0 = control			1 = decrease		0 = control		
	Mean (%)	SD	Mean (%)	SD	Mean (%)	SD	p value	Mean (%)	SD	Mean (%)	SD	p value
Depression level (0–5)	1.76	1.44	1.87	1.39	1.61	1.50	−0.260***	1.76	1.42	1.60	1.45	−0.165**
≤ 2.4	67.76		65.58		71.11			66.23		71.65		
> 2.4	32.24		34.42		28.89			33.77		28.35		
Gender							−0.034*					0.004
Female	45.57		44.24		47.61			46.17		45.80		
Male	54.43		55.76		52.39			53.83		54.20		
Age (16–70)	32.40	9.63	31.09	9.11	34.42	10.1	3.332***	32.98	9.75	32.75	9.59	−0.230
Education years	14.02	2.84	13.87	2.79	14.25	2.91	0.376***	13.96	2.78	14.06	3.10	0.096
Party membership							0.091***					−0.007
Non-party member	72.79		76.40		67.26			70.05		70.73		
Party member	27.21		23.60		32.74			29.95		29.27		
Household registration							0.368***					0.000
Urban areas	17.05		20.38		11.94			13.19		15.35		
Rural–urban fringe	10.59		12.23		8.09			10.69		8.66		
Town	19.12		20.38		17.18			20.71		18.24		
Countryside	53.24		47.01		62.79			55.41		57.74		
Job status							0.031***					0.002
No job	7.82		9.06		5.93			7.39		7.22		
Had a job	92.18		90.94		94.07			92.61		92.78		
Social status (1–10)	5.58	2.14	5.44	2.13	5.79	2.13	0.359***	5.67	2.03	5.63	2.15	−0.042
Resilience	3.38	1.22	3.32	1.17	3.46	1.29	0.137***	3.39	1.21	3.38	1.29	−0.011
Quarreled with family							−0.099***					0.014
No at all	43.29		41.47		46.07			43.40		42.13		
Ordinary	44.60		44.34		44.99			45.65		46.85		
Very frequent	12.12		14.19		8.94			10.95		11.02		
Conflicts with personnel							0.015*					0.007
No conflicts	5.05		5.64		4.16			5.01		4.33		
Had conflict	94.95		94.36		95.84			94.99		95.67		
COVID-19 cases							−0.019**					−0.011
No cases	93.36		92.60		94.53			93.01		94.09		
Had cases	6.64		7.40		5.47			6.99		5.91		
Subjective feelings about strictness							0.047					0.030
Not at all	2.50		2.11		3.08			2.37		2.89		

(Continued)

TABLE 2 (Continued)

| | Total | | Unmatched | | | | | Matched | | | | |
| | | | 1 = decrease | | 0 = control | | | 1 = decrease | | 0 = control | | |
	Mean (%)	SD	Mean (%)	SD	Mean (%)	SD	p value	Mean (%)	SD	Mean (%)	SD	p value
Not too much	2.83		3.37		2.00			2.64		1.97		
Ordinary	7.46		8.10		6.47			8.84		6.69		
Relatively	32.94		33.42		32.20			31.27		32.55		
Very strict	54.28		52.99		56.24			54.88		55.91		
Frequency of going out							0.026					−0.034
Not at all	64.81		65.53		63.71			63.98		66.80		
Not too much	28.16		27.43		29.28			28.23		26.38		
Ordinary	5.72		5.99		5.32			6.33		5.12		
Relatively	0.94		0.75		1.23			1.06		1.18		
Very frequent	0.37		0.30		0.46			0.40		0.52		
Sleep health (0–40)	21.23	7.91	20.36	7.90	22.58	7.74	2.221***	21.06	7.91	21.60	7.86	0.534
Pandemic information (0–10)	2.46	1.66	2.50	1.66	2.38	1.66	−0.120**	2.38	1.61	2.44	1.70	0.060
Encounters (0–6)	1.34	1.45	1.43	1.43	1.22	1.46	−0.205***	1.28	1.37	1.35	1.57	0.068
City							−0.035					0.000
Wuhan	28.01		27.83		28.27			28.76		28.22		
Other cities in Hubei	40.52		39.51		42.06			38.79		41.08		
Henan/ Hunan/Anhui	6.70		7.85		4.93			8.05		5.12		
Other provinces	24.78		24.81		24.73			24.41		25.59		
Total	3,285		1,987		1,298			758		762		

SD, standard deviation. *$p < 0.1$, **$p < 0.05$, ***$p < 0.01$. Wuhan is the capital city of Hubei Province. Henan/Hunan/Anhui are three provinces near Hubei.

being relevant. To consider potential correlation across observations for districts within the same cooperative arrangement, we clustered our estimations by the unit of the city. The Durbin–Watson statistics of our models indicated no autocorrelation problems in unmatched models. After introducing propensity score weighting, matched models unavoidably exhibited a certain degree of autocorrelation. The Shapiro–Wilk test showed that some variables were not distributed normally. Therefore, we used the robust regression method to test the structural models.

Table 5 presents estimates of the average effect of income decrease on depression levels (standard errors in parentheses) with different specifications. The results seemed relatively robust, with coefficient estimates consistently positive and remaining significant after adding all covariates (Model 3, $\beta_{matched} = 0.117$**, $R^2 = 0.203$). This outcome suggests that a greater decrease in income was correlated with a worse degree of depression symptoms. At the same time, the models suggest that people living near the city center, people who have stronger psychological resilience, people who encountered more negative experiences, people who felt lockdown policies were less strict, and people who had conflicts with pandemic protection personnel reported higher depression levels. Having COVID-19 cases in the family, having more time spent with pandemic information, having more frequent quarreling with family, and having worse sleep health were significantly correlated with higher depression after adjustment.

4.3. Moderate effect

Next, we tested the moderating effects by adding the interaction of income decline and resilience in Stata software, version 17.0. Our goal was to further investigate the boundary condition of when the income decrease of the public influenced its depression level.

TABLE 3 Balancing hypothesis testing showing the variables' characteristics before and after matching.

Variables	Unmatched	Mean		Bias (%)	t value	p value
	Matched	Treated group	Control group			
Gender	U	0.558	0.524	6.8	1.9	0.058
	M	0.555	0.556	−0.2	−0.06	0.949
Age	U	31.086	34.418	−34.7	−9.83	0.000
	M	31.146	31.374	−2.4	−0.79	0.432
Education	U	13.870	14.246	−13.2	−3.71	0.000
	M	13.890	13.863	0.9	0.29	0.770
Party	U	0.236	0.327	−20.4	−5.78	0.000
	M	0.238	0.236	0.3	0.11	0.911
Household registration	U	2.940	3.308	−32.9	−9.11	0.000
	M	2.955	2.982	−2.5	−0.72	0.470
Job status	U	0.909	0.941	−11.9	−3.27	0.001
	M	0.913	0.913	−0.2	−0.06	0.955
Social status	U	5.436	5.795	−16.9	−4.72	0.000
	M	5.432	5.416	0.8	0.23	0.817
Resilience	U	3.323	3.460	−11.2	−3.16	0.002
	M	3.327	3.286	3.3	1.03	0.304
Quarreled with family	U	1.727	1.629	14.7	4.1	0
	M	1.722	1.758	−5.3	−1.6	0.109
Conflicts with personnel	U	0.944	0.958	−6.8	−1.89	0.059
	M	0.944	0.953	−4	−1.23	0.221
Covid cases	U	0.074	0.055	7.9	2.17	0.030
	M	0.073	0.058	6	1.86	0.062
Subjective feelings about strictness	U	4.318	4.365	−5.1	−1.44	0.150
	M	4.317	4.359	−4.6	−1.47	0.141
Frequency of going out	U	1.429	1.455	−3.8	−1.06	0.288
	M	1.429	1.420	1.3	0.42	0.675
Sleep health	U	20.356	22.578	−28.4	−7.94	0.000
	M	20.428	20.451	−0.3	−0.09	0.930
Pandemic information	U	2.504	2.384	7.2	2.02	0.044
	M	2.497	2.503	−0.4	−0.11	0.912
Encounters	U	1.426	1.221	14.2	3.98	0.000
	M	1.413	1.423	−0.7	−0.22	0.826
City	U	2.296	2.261	3.1	0.88	0.379
	M	2.299	2.282	1.5	0.48	0.633

U, Unmatched; M, Matched.

We found that the estimated effect of income decrease on depression was significant ($\beta = 0.264^{***}$, SD = 0.063, $p = 0.000$), and the interaction was significant ($\beta = -0.184^*$, SD = 0.100, $p = 0.066$). This finding suggests that resilience as a moderator could weaken the relationship between decreased income and depression levels, indicating that the depression level caused individuals' economic decline will diminish as psychological resilience increases. Thus, *H2* was supported (see Table 6 and Figure 1).

5. Discussion

Our study revealed that, for participants who reported a decrease in economic status, an increase in depression levels was discovered compared to those with a constant economic status. Each decrease in the unit of economic status raised the level of depression by approximately 0.117 units. In addition, the results of this study demonstrate that psychological resilience significantly moderates the

TABLE 4 Average treatment effect of income declines on depression level.

	Coefficient	AI robust std. err.	z	p > z	[95% conf. interval]	
Total	0.247	0.068	3.66	0.000***	0.115	0.380
In Hubei	0.163	0.086	1.890	0.058*	−0.006	0.332
Not in Hubei	0.204	0.123	1.660	0.097*	−0.037	0.445
Rural area	0.379	0.109	3.490	0.000***	0.166	0.592
Urban area	0.208	0.095	2.180	0.029**	0.021	0.395
Cases	0.278	0.144	1.930	0.053*	−0.004	0.559
No cases	0.251	0.070	3.570	0.000***	0.113	0.389

$*p < 0.1; **p < 0.05; ***p < 0.01$.

relationship between a decline in economic status and depression ($−0.184*$). In short, both of the hypotheses that we proposed were strongly supported.

5.1. The vital role of economic status in mental health indications

We first hypothesized that when experiencing a more severe economic status decline, individuals' depression levels will be worse impacted. Consistent with previous studies (55, 56), our findings suggested that a more severe economic status decrease caused greater depression in individuals after a huge global crisis, such as the COVID-19 pandemic. A large proportion of the general population suffered from the suspension of work activities or was forced to work remotely during the pandemic outbreak. Some individuals even experienced the loss of job positions due to the economic recession (55). Under chronic job insecurity and financial threat, individuals have less sense of control and may experience more concerns about maintaining current living standards, which are significant risk factors for developing depression. Our findings further justified that economic standing could be an influencing factor in mental health status. Although existing studies have made significant contributions to understanding SES changes and depression under public health emergencies, we consider it essential to investigate whether a decrease in economic status would lead to depression in people living in the region where the pandemic originated and was most influenced at the beginning of COVID-19 specifically. The Hubei Province of China, with the center of Wuhan City, was where the coronavirus was first discovered and was affected the most due to a lack of knowledge about the virus transmission route and protection methods from infection.

5.2. The moderating effect of psychological resilience

Our second hypothesis of the moderating effect of psychological resilience was also supported by the findings. The psychological resilience level of participants in our sample was 3.38 on average. Our findings demonstrated that the negative influence of economic status decline on depression is lower in individuals with a higher degree of resilience. This result is in line with prior studies regarding the protective effects of resilience on mental well-being (39, 57). A study

conducted in Wuhan, China (39), during the first outbreak of the pandemic also concluded that resilience is negatively associated with anxiety and depression in patients with less severe infection. On the one hand, with a higher level of resilience, individuals living in the pandemic control region have higher psychological resources to confront the negative mental influences brought by the decline of economic status. On the other hand, the decline in economic status could negatively influence the level of psychological resilience since income has been proven to be a significant indicator of the resilience of individuals (40). Therefore, when suffering a decline in economic standing, individuals may have less resilience as personal resources to protect them from developing depressive symptoms.

5.3. Other findings

According to the ripple effect model, individuals have higher risk perceptions and negative affection for a crisis when they are closer to the center of it (1). Nevertheless, apart from what most of the crisis literature and the ripple effect suggested, our findings demonstrated that, for residents who were not in Hubei during the pandemic outbreak in January 2020, their depression level was influenced even more by a decrease in economic status compared to that of residents who lived in Hubei at the time. A possible explanation could be that working and living in a city other than their home, individuals might face more financial stress regarding affording household expenses, paying housing rents, etc. When feeling that their economic status is greatly influenced by a global health crisis that is uncontrollable by individual forces, migrant workers are more likely to suffer from negative psychological well-being since they encounter more stress in life and have less support from family and friends. Therefore, our findings point out the need for attention and support, not only to residents who lived in the center of a crisis but also to the migrant population originating from the crisis center. The numerous cases of financial loss and negative mental health outcomes of Hubei residents and migrant Hubei residents during the pandemic should receive more attention from the government and the public since these people encountered relatively more detrimental influences compared to those in other regions. Although Hubei people who work and live in places other than their hometowns were previously ignored by researchers, our study suggests the latent risk of depression in this population. More investments in attention and resource allocations to this group in

TABLE 5 Effect of income decline on depression level.

	Model 1		Model 2		Model 3	
	Unmatched	Matched	Unmatched	Matched	Unmatched	Matched
Income decline	0.262***	0.0564	0.251***	0.00915	0.171***	0.117**
	(0.0522)	(0.0509)	(0.0535)	(0.0533)	(0.0504)	(0.0487)
Gender			−0.00893	−0.118**	−0.00491	−0.113**
			(0.0509)	(0.0506)	(0.0475)	(0.0458)
Age			−0.000113	0.00921***	−0.00165	0.00220
			(0.00274)	(0.00281)	(0.00254)	(0.00251)
Education			0.0149	−0.0101	0.00690	−0.0216**
			(0.0101)	(0.0100)	(0.00917)	(0.00906)
Party			0.0325	0.119*	−0.0425	0.00459
			(0.0614)	(0.0624)	(0.0572)	(0.0565)
Job status			0.0343	0.143	−0.0958	0.0121
			(0.111)	(0.112)	(0.104)	(0.103)
Household registration			−0.0512**	−0.0678***	−0.0551**	−0.0727***
			(0.0248)	(0.0245)	(0.0233)	(0.0225)
Social status			−0.00858	0.0596***	−0.0180	0.0407***
			(0.0150)	(0.0140)	(0.0137)	(0.0127)
Resilience					0.386***	0.425***
					(0.0211)	(0.0192)
Quarrel with family					0.129***	0.183***
					(0.0360)	(0.0361)
Conflict with personnel					−0.295***	−0.285***
					(0.0937)	(0.102)
COVID-19 cases					0.207**	0.246***
					(0.0839)	(0.0720)
Subjective feelings about strictness					−0.135***	−0.148***
					(0.0266)	(0.0262)
Frequency of going out					0.0319	0.0682**
					(0.0345)	(0.0340)
Pandemic information					0.0323**	0.0263*
					(0.0150)	(0.0158)
Sleep health					−0.0284***	−0.0324***
					(0.00317)	(0.00320)
Encounters					0.0665***	0.0803***
					(0.0171)	(0.0163)
Other cities in Hubei	−0.0102	−0.190***	−0.0319	−0.181***	−0.0585	−0.162***
	(0.0616)	(0.0635)	(0.0629)	(0.0650)	(0.0591)	(0.0595)
Henan/Hunan/Anhui	−0.0925	0.0648	−0.126	0.0463	−0.104	0.00217
	(0.110)	(0.109)	(0.114)	(0.116)	(0.0999)	(0.0986)
Other provinces	−0.108	−0.282***	−0.141*	−0.291***	−0.0415	−0.209***
	(0.0712)	(0.0710)	(0.0757)	(0.0762)	(0.0705)	(0.0686)
_cons	1.641***	1.797***	1.633***	1.441***	1.748***	1.637***
	(0.0590)	(0.0571)	(0.235)	(0.224)	(0.267)	(0.251)
VIF	1.00	1.00	1.19	1.20	1.16	1.19

(Continued)

TABLE 5 (Continued)

	Model 1		Model 2		Model 3	
	Unmatched	Matched	Unmatched	Matched	Unmatched	Matched
B-P/C-W Test p =	0.019**	0.1925	0.000***	0.004***	0.000***	0.000***
Durbin–Watson	1.991	0.943	1.990	0.943	1.978	0.9578
N	3,285	3,260	3,285	3,260	3,285	3,260
R^2	0.009	0.008	0.011	0.021	0.148	0.203

Standard errors in parentheses. *$p < 0.1$, **$p < 0.05$, ***$p < 0.01$.

TABLE 6 Estimation of moderate effect.

	Coefficient	Robust std. err.	t	$p > t$	[95%conf. interval]	
Income decline	0.264	0.063	4.20	0.000	0.141	0.388
Resilience	0.563	0.079	7.09	0.001	0.407	0.719
Interaction	−0.184	0.100	−1.84	0.066	−0.379	0.012

FIGURE 1
Moderate effect.
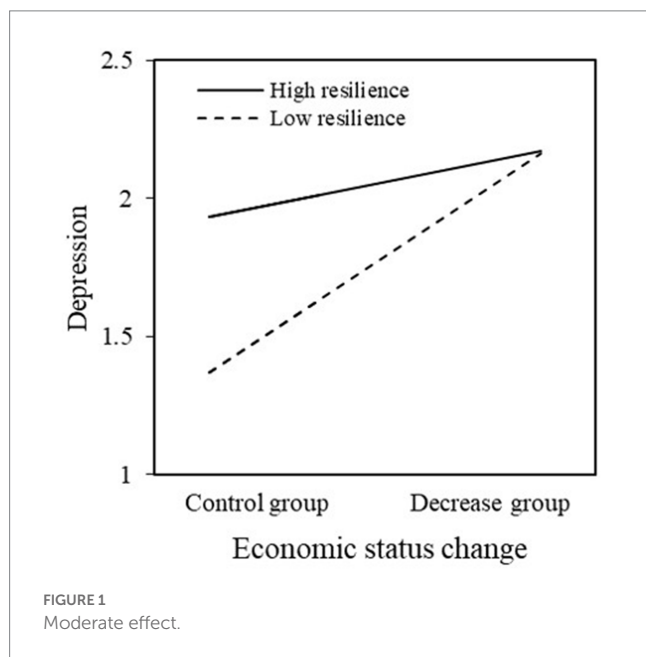
future crises that could lead to large-scale economic regression and psychological distress in people are necessary.

Moreover, our results demonstrated that the effect of decreased economic status on depression symptoms was also determined by the place of residence. For participants living in rural areas, an objective decrease in their economic standing led to a worse level of depression compared to those who live in urban areas. This outcome could be attributed to worry about a lack of effective medical resources or treatment in rural areas for potential infection. Additionally, whether one's self, one's family or one's relatives were in close contact with infected cases, infected, or died due to infection is another variable that differentiated the influence of economic status decline on the development of depressive symptoms. Participants who reported having COVID-19 cases in their families showed more deteriorated depressive levels when their economic status decreased during the pandemic. This finding could be explained by discrimination against infected patients

during the outbreak. Due to the lack of knowledge and effective treatment methods at the beginning of the pandemic, being infected could lead to consequences for long-term treatment under quarantine. Although patients recovered, they could face unemployment because of workplace discrimination. Therefore, being infected or having a family member who tested positive for COVID-19 could result in a decrease in household income and negatively influence one's economic status.

5.4. Limitations and future studies

Although the present study provides some meaningful initial evidence to understand the impact of economic status decline on the mental well-being of the public during the postpandemic era, several limitations should be stated clearly to clarify the effective implications of our findings and the development of future research. First, our data were collected through an online questionnaire based on a trade union platform, which lacks representativeness compared to random sampling. However, we took various measures to reduce sampling bias. Second, our sample was between 20 and 40 years old and was recruited from the region where the first outbreak of COVID-19 occurred, which is the Hubei Province of China, instead of nationwide or globally. Therefore, the results of this study are not generalizable to a broader population with different ages, cultures, or severities of pandemic impacts. Third, we adopted WHO-5 as our measurement tool for depression, even though it is commonly regarded as a screening tool for detecting depression rather than reflecting the severity of depression. However, due to its cost-effectiveness, non-invasiveness, and limited evidence supporting its use for assessing depression severity (45), we decided to include WHO-5 in the questionnaire as a means of assessing depression. Nevertheless, although these inevitable factors limited the present study, our study still provided novel and meaningful contributions in that our data comes from a large population in the region the COVID-19 was first discovered.

Future research studying the influence of economic status changes on depression could focus on more diverse and broader populations.

For example, researchers could investigate how a decline in household economic status affects the depression levels of children or elderly people from Western cultural backgrounds in different stages of infectious disease outbreaks.

5.5. Implications

It is worth mentioning that, unlike existing studies regarding the immediate influences of SES decreases on psychological well-being, the current study focused on investigating the relationship between SES and depression approximately half a year after the world's first outbreak of the COVID-19 pandemic. Studying the postpandemic period is essential since valuable results generated from these studies could guide us in formulating a more effective and precise plan to confront the detrimental consequences of crises and to construct a more extensive and systematic risk response plan to lower the threat when future crises occur. The Guiding Principles for Emergency Psychological Crisis Intervention in the Outbreak of Novel Coronavirus Pneumonia, issued by the National Health Commission during the pandemic, note that the public in the pandemic area is the fourth-level target population for psychological interventions, suggesting that communities should pay attention to the mental health status of residents and meet the needs of residents (4). Nevertheless, reconstruction practices for communities in Hubei and interventions for Hubei residents should also be greatly promoted in the postpandemic era to decrease the negative influences caused by the global health crisis. Effective psychological interventions and services should be provided to the public to prevent detrimental experiences of stress, trauma, and emotional distress from developing into chronic psychological disorders such as PTSD, anxiety, and depression.

Additionally, the results of the present study point out the necessity to improve the level of resilience of the public regarding preventing psychological detriments from coming with future crises. Higher resilience possibly helps to prevent negative affect from developing into chronic mental disorders. Therefore, governments should invest in exploring effective resilience improvement programs to help individuals to develop a higher level of resilience, which could be beneficial for them to withstand various threats, not only at the macro scale but also at the individual level. Unlike survivors of other crises, individuals during the COVID-19 outbreak were required to be socially isolated from others, which led to the loss of social support and networks to a great extent (58). Social support, as an aspect of interpersonal resources, has proven to be an essential factor in increasing resilience (59, 60). Due to the loss of social connections during the global health crisis, individuals could have less support helping them to remain positive to confront threats that come with crises. Hence, social support is inevitably a vital component to consider when relevant governments and social sectors formulate crisis response strategies and policies. Cutting the social connections of individuals should be prevented to a great extent to maintain individuals' sources of obtaining social support and cultivating resilience. In addition, policy-makers and relative social sectors should expand methods to provide more social support to individuals during crises. For example, crisis interventions and psychological counseling services could be effective ways to socially support individuals during extreme traumatic events.

Our study also provides empirical evidence to support theories. First, consistent with the Opportunity and Stress Hypothesis (6), our findings suggested that a greater decrease in economic standing generates worse depression levels in individuals. The Opportunity and Stress Hypothesis claims that people with more disadvantaged SES have less social capital to confront crises in life. When individuals experience financial loss during the pandemic, they could fall into a situation in which fewer resources can be utilized to face the negative consequences of the pandemic. Economic challenges can also become a chronic stress situation in families, which can generate distressing thoughts about paying household expenses and lead to fear, anxiety, and uncertainty regarding one's ability to maintain the current standard of living (55). Being restricted and isolated at home for two and a half months, residents of Hubei could feel insecure about their jobs and financial situation, increasing their risk of depression during the infectious disease outbreak. Second, the current study also provided support for the protective model of psychological resilience, which proposes the protective effect of stress resistance against the development of psychopathology under stress generated from risk factors (41). Stress resistance, as a vital assessing element of resilience and coping, represents individuals' competence to confront the negative effects of stressful events. Possessing a higher level of competence when facing stressors in life, individuals have higher resilience to protect themselves from developing negative psychological outcomes. In line with this model, our findings further demonstrated that a higher level of psychological resilience could protect individuals who suffered from the decline in economic status from developing more severe depressive symptoms. Third, the present study further supported the Richardson model of psychological resilience. The Richardson model mentions that when under colossal stress levels, individuals' mental and physical equilibrium will be broken due to the suddenly increased risk factors (8). However, individuals with higher levels of protective factors to defend against negative influences will be able to maintain their equilibrium and protect their mental wellness. Psychological resilience, as an individual's own quality and ability, represents an immaterial and internal competence that can be utilized to cope with crisis. Therefore, the power of psychological resilience in achieving the state of equilibrium was emphasized in this study. The lower level of depression demonstrated in individuals with higher psychological resilience as a personal protective resource championed the Richardson model regarding psychological equilibrium.

Data availability statement

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

Author contributions

JW contributed to conception and design of the study. JH organized the database. LL performed the statistical analysis. YC, LL, and JH wrote sections of the manuscript. All authors contributed to the article and approved the submitted version.

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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Content specificity of attentional bias to COVID-19 threat-related information in trait anxiety

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Introduction: Anxious individuals selectively attend to threatening information, but it remains unclear whether attentional bias can be generalized to traumatic events, such as the COVID-19 pandemic. Previous studies suggested that specific threats related to personal experiences can elicit stronger attentional bias than general threats. The current study aimed to investigate the relationship between content-specific attentional bias and trait anxiety during the COVID-19 pandemic.

Methods: Attentional bias was assessed using the dot-probe task with COVID-19-related, general threat-related, and neutral words at two exposure times, 200 and 500 ms.

Results: We found participants with high trait anxiety exhibited attentional bias toward COVID-19- related stimuli and attentional bias away from general threat-related stimuli, while participants with low trait anxiety showed attentional bias away from both types of stimuli.

Discussion: Results suggest that individuals with high trait anxiety show a content-specific attentional bias to COVID-19-related information during the COVID-19 pandemic. Apart from the innate attentional bias toward biological threats, individuals with high trait anxiety may also learn from trauma and develop trauma-specific attentional bias.

KEYWORDS

attentional bias, COVID-19, trait anxiety, dot-probe task, content specificity

1. Introduction

The COVID-19 pandemic has had a profound impact on multiple aspects of life, causing widespread traumatic stress for many people (1). In March 2022, Shanghai was confronted with a recurrence of the COVID-19 pandemic, leading to the adoption of lockdown and quarantine policies in high-risk areas. Citizens in Shanghai faced enormous uncertainty and psychological challenge. The COVID-19 pandemic has been consistently proven to elevate people's anxiety symptoms (2), but interrelatedly, anxious individuals may also selectively attend to negative information regarding the COVID-19 pandemic (3). This differential attentional allocation toward threatening stimuli compared with neutral stimuli is conceptualized as attentional bias (4, 5). Attentional bias is also considered an underlying mechanism of the development and maintenance of anxiety disorders (6). From an evolutionary perspective, the selective attentional mechanisms toward environmental threats have survival significance (7). However, the persistence of attentional bias toward

COVID-19-related negative information may exacerbate anxiety symptoms and interfere with individual's ability to cope effectively.

Previous studies have suggested that there was a positive association between attentional bias toward COVID-19-related stimuli and anxiety symptoms. For example, Cannito et al. (3) found levels of health anxiety predicted attentional bias toward COVID-19 virus-related objects in the dot-probe task. Similarly, Albery et al. (8) found the attentional bias indices were positively correlated with COVID-19 anxiety syndrome using the same task. However, it remains unclear whether anxious individuals exhibit a stronger attentional bias toward COVID-19-related stimuli compared to general threat-related stimuli after chronic exposure to the COVID-19 pandemic. The relationship between anxiety and COVID-19-related attentional bias can shed light on anxious people's susceptibility to traumatic events. Apart from the innate attentional bias toward biological threats, they may also learn from trauma and develop a trauma-specific attentional bias. This specific hypervigilance toward potential threats may contribute to the development of anxiety disorders. Thus, exploring attentional bias in the COVID-19 pandemic has implications for research on anxiety disorder mechanisms and for anxiety disorder intervention.

A prior meta-analysis indicates that specific threatening stimuli which is related to individuals' anxiety type (e.g., faces for social phobia) can elicit a stronger attentional bias than general threat-related stimuli (9). This small but significant effect is not moderated by age, type of anxiety disorder, experimental paradigms, and type of content-incongruent threatening stimuli. Considering that anxiety symptoms are linked to unique patterns of processing personally related threatening information (10), individuals with elevated anxiety symptoms may prioritize and show heightened sensitivity toward specific threats which are related to their experiences or concerns (9). For example, Zinchenko et al. (11) found that individuals with post-traumatic stress disorder (PTSD) who had survived a factory collapse exhibited a content-sensitive dissociation when faced with emotional stimuli. They responded more quickly to emotional buildings than neutral buildings, while they responded more slowly to emotional faces than neutral faces. However, conflicting results regarding specificity have also been reported. For instance, Maidenberg et al. (12) found that participants with panic disorder responded slower to both panic-related and general threat-related words than healthy participants. Thus, further research is needed to explore the specificity in anxiety-linked attentional bias. Moreover, most previous studies have focused on PTSD or a specific anxiety disorder (e.g., social anxiety disorder or spider phobia), while research on specificity in trait anxiety is scarce. Pergamin-Hight et al. (9) have recommended future research to focus on personalized specificity in anxiety disorders where worry is not specific, such as generalized anxiety disorder and trait anxiety. The personalized approach could examine a higher order of content specificity beyond disorder-congruent content and contribute to the optimization of Attention Bias Modification Treatments (ABMT), providing both theoretical and intervention implications.

Individuals with high levels of trait anxiety have been shown to process and react differently to threat-related resources compared to those with low levels of trait anxiety (13). Trait anxiety is associated with exaggeration of the risk of encountering threats and the risk of facing adverse outcomes caused by the threats (14), as well as a memory bias toward threatening information

(15). Furthermore, individuals with high levels of trait anxiety have lower cognitive flexibility (16, 17), making it harder for them to adjust their behavioral, emotional, and cognitive responses when facing new information. During the COVID-19 pandemic, individuals high in trait anxiety may allocate more attention to COVID-19-related information, interpret the pandemic as having a catastrophic outcome (e.g., long-term lockdown, shortages of food supplies), exhibit an enhanced memory of negative news related to the COVID-19 pandemic, and experience maladaptation. Chronic exposure to stressful environments may contribute to attentional bias toward threats (18), and the attentional bias after trauma exposure occurs regardless of PTSD (19). Therefore, it is hypothesized that individuals high in trait anxiety will exhibit attentional bias toward both general threat-related stimuli and COVID-19-related stimuli.

COVID-19 stimuli are distinct from ordinary disease stimuli as they have a comprehensive impact on multiple domains of life. As proposed by Taylor (20), the psychological challenges brought about by pandemics are dynamic in nature. Initially, contamination concerns were the primary challenge, but over time, the COVID-19 pandemic has given rise to concerns about unemployment, food shortages, social restrictions, quarantine, and financial issues (21). Thus, it may be hypothesized that attentional bias toward COVID-19-related stimuli is more likely to be associated with anxiety symptoms at a general level (e.g., trait anxiety) rather than being solely linked to health anxiety.

Regarding the temporal mechanisms underlying attentional bias, there has been consistent debate on whether anxiety symptoms are linked with elevated orienting toward, or impaired disengagement from, threatening stimuli. The vigilance-avoidance model and the attention maintenance model emerged as two dominant views. In the vigilance-avoidance model, anxious individuals demonstrate an initial vigilance toward threatening stimuli and a subsequent avoidance away from the stimuli (22). In contrast, in the attention maintenance model, anxious individuals experience difficulty in disengaging from threatening stimuli (23). Both two models were supported by empirical evidence. For example, Mogg and Bradley (24) found attentional vigilance at a shorter exposure time (100 ms) and found subsequent attentional avoidance at a longer exposure time (500 ms) in a sample of non-clinical anxious individuals. Difficulty in disengagement was also invariably found in anxious individuals (25, 26). Although the two models are seemingly incompatible, recent studies have discovered that engagement and disengagement may coexist in attentional bias as independent pathways (27, 28). Individuals may at first exhibit facilitated vigilance toward threat-related stimuli, and then overtly avoid the threat while covertly processing the threatening information (29).

A range of experimental paradigms have been developed to measure attentional bias, including the widely-used dot-probe task. In this task, a neutral stimulus and a threat-related stimulus are presented simultaneously on a computer screen (5). Subsequently, a probe appears in one of the two locations previously occupied by the stimuli, either in the same location as the threat-related stimulus (congruent trial) or in the opposite location (incongruent trial). Participants are instructed to respond as quickly as possible to the probe's appearance. The dot-probe task has several advantages over other measures of attentional bias. Firstly, it can be used to assess both the direction and magnitude of attentional bias (30).

Additionally, the dot-probe task involves competition between two stimuli, which makes it more sensitive to the occurrence of attentional bias than other tasks, such as the spatial cueing task, which only presents one stimulus at a time (4).

A previous meta-analysis suggested that stimuli types (words or pictures) may also be an important factor in the dot-probe task (4). Specifically, it was found that subclinical anxious individuals exhibited attentional bias toward both word and picture stimuli, without significant differences between the two. However, pictures may not be explicit enough to represent abstract concepts related to COVID-19, such as quarantine, fever, and contagion. Words may be more appropriate in the context of the COVID-19 pandemic, as they can remove ambiguity. It was also suggested that word stimuli were more appropriate than picture stimuli when the threatening information was conceptual instead of perceptual (29). Thus, the current study utilized word stimuli.

Due to the inconsistent results in previous COVID-19-related attentional bias studies and the lack of evidence regarding how trait anxiety is associated with COVID-19 attentional bias, further research is needed. According to evolutionary models, all humans possess an innate ability to rapidly detect environmental threats of survival significance, regardless of their susceptibility to anxiety (22). However, it remains unclear whether selective attentional allocation can also be acquired through stressful experiences. The current study aims to explore whether individuals with high trait anxiety are more prone to learn from their stressful experiences and develop exaggerated psychological responses than individuals with low trait anxiety. This content-specific hypervigilance toward potential threats may be attributable to trait anxiety and may contribute to the development of anxiety disorders. Additionally, the current study aims to verify whether individuals with low trait anxiety selectively attend to general threat-related or COVID-19-related stimuli. The current study utilized the dot-probe task to examine the association between trait anxiety and attentional bias toward COVID-19-related and general threat-related word stimuli in two presentation times (200 and 500 ms) during the COVID-19 pandemic. We hypothesize that individuals with high trait anxiety would exhibit attentional bias toward both COVID-19-related and general threat-related stimuli, and the effect of attentional bias toward COVID-19-related stimuli would be stronger. We also hypothesize that individuals with low trait anxiety would not exhibit attentional bias toward COVID-19-related or general threat-related stimuli.

2. Materials and methods

2.1. Participants

A priori power analysis using G*power 3.1.9.7 (31) was performed to estimate the sample size necessary for the interaction effect at 90% power. The effect size was set to $f = 0.15$. Assuming a two-tailed alpha of.05, 31 participants per group resulted in power of 80%. Thus, the required sample size is 62 participants.

In the current study, 62 Shanghai university students were recruited (42 females, age $M = 20.27$, $SD = 1.20$). The participants were all right-handed, without physical disease, had normal or corrected-to-normal vision and had no color blindness or color weakness. Participants were also evaluated using the Chinese

TABLE 1 The extent to which participants were affected by the COVID-19 pandemic.

	Category	N (percentage)
When was the last COVID-19 case detected in your district? error bars stand for	Within 2 days	14 (22.59%)
	Between 2 days and 6 days	5 (8.06%)
	Between 7 days and 14 days	10 (16.13)
	14 days ago	33 (53.23%)
Is there a limit on your outdoor activities?	Can't go outdoors	19 (30.65%)
	Can't go outside the campus or the community	25 (40.32%)
	No limit	18 (29.03%)
How long have you been quarantined?	Shorter than 2 days	43 (69.35%)
	Between 2 days and 6 days	1 (1.61%)
	Between 7 days and 14 days	11 (17.74%)
	Longer than 14 days	7 (11.29%)

version of the Mini International Neuropsychiatric Interview by phone calls (32, 33). No participant was diagnosed with psychiatric disorders. The experiment was conducted between April 23, 2022, and May 7, 2022, during which Shanghai was confronted with a recurrence of the COVID-19 pandemic. All participants had been influenced by the COVID-19 lockdown measures (e.g., experiencing difficulties in buying food, or being quarantined). Information regarding the extent to which participants were affected by the COVID-19 pandemic is presented in **Table 1**.

2.2. Measures

2.2.1. State-trait anxiety inventory, STAI-T

Trait anxiety was assessed using the Chinese version (34) of the State-Trait Anxiety Inventory [STAI-T; (35)]. The scale consists of 20 items which are scored on a 4-point Likert scale. Higher scores indicate higher levels of trait anxiety. In the current study, the scale's Cronbach's α was 0.86.

2.2.2. Exposure extent

Three items were created to assess the extent of exposure to the COVID-19 pandemic. The three items were: When was the last COVID-19 case detected in your district (Within 2 days = 4, Between 2 days and 6 days = 3, Between 7 days and 14 days = 2, 14 days ago = 1), Is there a limit on your outdoor activities (Can't go outdoors = 3, Can't go outside the campus or the community = 2, No limit = 1) and How long have you been quarantined (Shorter than 2 days = 1, Between 2 days and 6 days = 2, Between 7 days and 14 days = 3, Longer than 14 days = 4). A general score for the extent of exposure to the COVID-19 pandemic was computed by summing the three item scores.

FIGURE 1
Examples of valid and invalid trials of the dot-probe task.
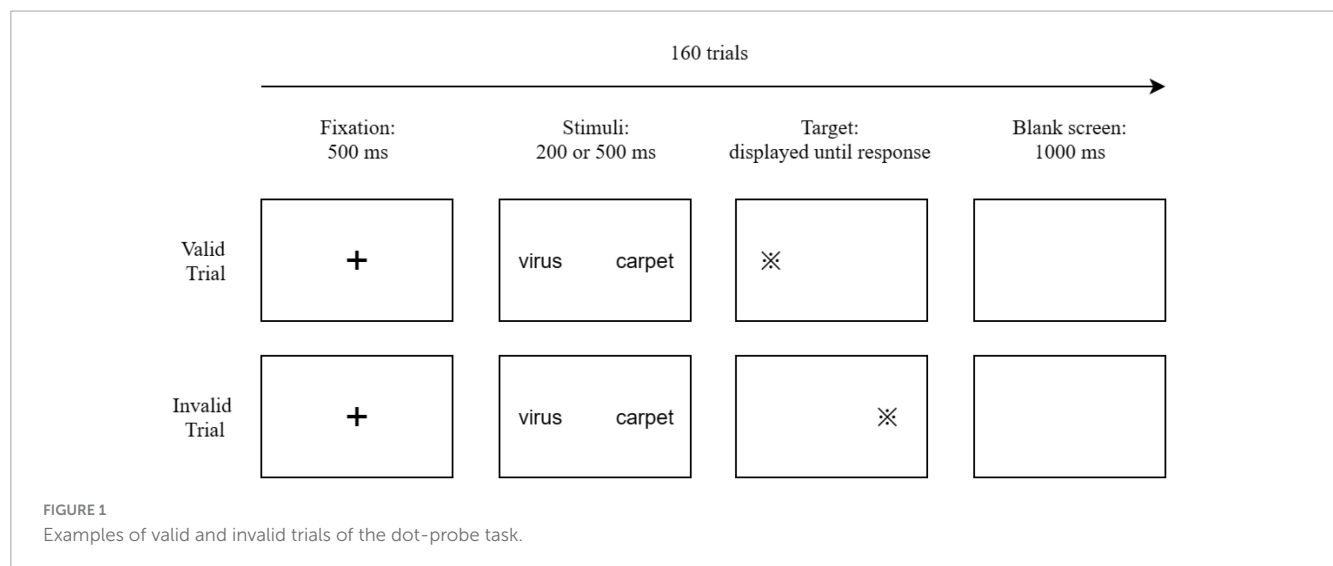
2.2.3. Experimental stimuli

The current study used word stimuli including COVID-19-related words, general threat-related words, and neutral words. COVID-19-related words were selected from the COVID-19 vocabulary approved by China International Publishing Group. General threat-related words and neutral words were taken from word lists used in previous studies examining attentional biases toward general threats (36) and the corpus of affective norms for Chinese words (37). The current study selected 10 COVID-19-related emotional words (e.g., mask, quarantine, pandemic), 10 general threat-related emotional words (e.g., violence, threat, murder), and 20 neutral words (e.g., wall, television, carpet). The used words are shown in the **Appendix**. All the words contained two Chinese characters and were equal in length. A neutral word was randomly paired with a COVID-19-related word or a general threat-related word to form 20 pairs of words. We recruited another 22 university students (15 females, age $M = 20.82$, $SD = 1.10$) to rate the valence and arousal of these word stimuli using a 9-point Likert scale (-4 = extremely negative or very low arousal; + 4 = extremely positive or very high arousal). There was a significant difference between the valence of COVID-19-related words ($M = –2.69$, $SD = 0.76$) and neutral words ($M = 0.57$, $SD = 0.41$), t (28) = 15.48, $p < 0.001$, and between general threat-related words ($M = –2.56$, $SD = 0.57$) and neutral words, t (28) = 17.35, $p < 0.001$, but there was no significant difference between the valence of COVID-19-related words and general threat-related words, t (18) = 0.43, $p = 0.68$. There was a significant difference between the arousal of COVID-19-related words ($M = 1.84$, $SD = 0.81$) and neutral words ($M = –2.78$, $SD = 0.45$), t (28) = 20.25, $p < 0.001$, and between general threat-related words ($M = 1.48$, $SD = 0.75$) and neutral words, t (28) = 19.49, $p < 0.001$, but there was no significant difference between the arousal of COVID-19-related words and general threat-related words, t (18) = 1.05, $p = 0.31$.

2.3. Procedure

Due to the COVID-19 pandemic, face-to-face experiments were restricted. Thus, we conducted an online experiment.

Informed consent was obtained from all participants before the start of the experiment. Participants were invited to fill out the STAI-T. Afterward, they read the instructions and completed the online experiment. The experiment was programmed in PsychoPy 2020.1.3 and was conducted on www.naodao.com. During the experiment, participants needed to share their computer screens with the researcher via an online meeting software to avoid distraction. The experiment adopted the dot-probe task. In each trial, a cross fixation " + " appeared in the center of the screen for 500 ms. After the fixation disappeared, one emotional word (COVID-19-related words or general threat-related words) and one neutral word were simultaneously presented on the left and the right parts of the screen. Emotional words and neutral words were presented at random positions on the left and right parts of the screen. The two words were colored white, spaced 12 cm apart, and were presented for 200 or 500 ms. After the words disappeared, a target dot ("※") randomly appeared at one of the previous positions occupied by the two words. Participants needed to press the key "F" or "J" to judge whether "※" was on the left or the right of the screen. After participants pressed the key, the trial terminated, and the next trial commenced after a 1,000 ms blank screen (see **Figure 1** for the trial structure). Before the formal experiment, the participants needed to complete 8 practice trials. Each practice trial contained two neutral words which would not appear in the formal experiment. The formal experiment contained 160 trials, and each pair of words appeared 8 times (balanced according to exposure times, positions of the emotional word, and congruent or incongruent conditions). The study protocol was approved by the University Committee on Human Research Protection of East China Normal University.

2.4. Data analysis

Reaction time (RT) data were analyzed after removing incorrect responses (3%). Median RTs were used to reduce the effect of outliers in the dot-probe task (38, 39). For each participant, we calculated the attentional bias index for each stimuli type (COVID-19 and general threat) at both exposure times (200 ms and

TABLE 2 The mean RTs (ms) for each condition in the dot-probe task (*SD*s in parentheses).

Exposure time	Stimuli type	Low trait anxiety		High trait anxiety	
		Congruent	Incongruent	Congruent	Incongruent
200 ms	Virus	397.57 (41.73)	396.57 (37.40)	401.57 (61.00)	408.77 (69.92)
	General threat	394.45 (33.16)	398.49 (46.26)	421.23 (106.06)	402.57 (62.32)
500 ms	Virus	419.41 (82.98)	403.75 (51.08)	416.08 (92.60)	429.34 (135.22)
	General threat	411.54 (76.15)	406.60 (54.33)	427.10 (108.95)	431.11 (94.74)

TABLE 3 Correlations among the study variables.

	1	2	3	4	5
1. Trait anxiety	–				
2. Exposure extent	−0.108	–			
3. Attentional bias index for COVID-19-related words under 200 ms	0.046	0.017	–		
4. Attentional bias index for COVID-19-related words under 500 ms	0.132	0.010	0.108	–	
5. Attentional bias index for general threat-related words under 200 ms	−0.157	0.051	−0.152	−0.479**	–
6. Attentional bias index for general threat-related words under 500 ms	−0.039	−0.186	−0.369**	0.286*	−0.369**

*$p < 0.05$, **$p < 0.01$.

500 ms) by subtracting the median RT in congruent trials when the probe appeared at the position of the threat from the median RT in incongruent trials when the probe appeared at the position of the neutral stimuli, according to Mogg et al. (40). Positive values of attentional bias index indicate vigilance toward threat-related words, while negative values indicate avoidance away from threat-related words. All statistics were computed using IBM SPSS Statistics 26.0.

3. Results

3.1. Descriptive statistics and correlations

The median STAI-T score was 43.5 ($M = 45.03$, $SD = 8.40$). In the current study, participants who had an STAI-T score below 43.5 were assigned to the low anxiety group ($N = 31$, 21 females, age $M = 20.06$, $SD = 1.03$) and participants who had an STAI-T score above 43.5 were assigned to the high anxiety group ($N = 31$, 21 females, age $M = 20.48$, $SD = 1.34$). The independent samples *t*-test showed there was a significant difference in the scores on STAI-T between the low anxiety group ($M = 38.23$, $SD = 3.96$) and the high anxiety group ($M = 51.84$, $SD = 5.66$), $t(60) = 10.97$, $p < 0.001$.

All participants had an accuracy rate above 80% ($M = 97\%$, $SD = 0.03$). We adopted an exclusion criterion on error rates above 20% used by Fani et al. (30). Thus, no participant was excluded from the analysis. The mean RTs in each condition for the dot-probe task are displayed in **Table 2**. Correlations among the study variables are displayed in **Table 3**.

3.2. Analysis of variance

We conducted a 2 × 2 × 2 mixed design analysis of variance (ANOVA) on attentional bias index with Anxiety Group (low and high) as a between-participant factor and Exposure Time (200 ms

and 500 ms) and Stimuli Type (COVID-19 and general threat) as within-participant factors. Anxiety Group had no main effect on the attentional bias index, $F(1, 60) = 1.68$, $p = 0.20$, $\eta_p^2 = 0.03$. Exposure Time had no main effect on the attentional bias index, $F(1, 60) = 0.02$, $p = 0.90$, $\eta_p^2 = 0.00$. Stimuli Type had no main effect on attentional bias index, $F(1, 60) = 0.54$, $p = 0.47$, $\eta_p^2 = 0.01$.

There was a significant Anxiety Group × Stimuli Type interaction on the attentional bias index (see **Figure 2**), $F(1, 60) = 4.40$, $p = 0.040$, $\eta_p^2 = 0.07$. Further simple effect analysis of the interaction revealed that participants in the high anxiety group paid more attention to COVID-19-related words ($M = 10.23$, $SD = 34.37$) than general threat-related words ($M = −7.33$, $SD = 31.26$), $p = 0.050$. For participants in the low anxiety group, there was no significant difference between COVID-19-related words ($M = −8.91$, $SD = 33.73$) and general threat-related words ($M = −0.46$, $SD = 21.69$), $p = 0.349$.

There was no significant Anxiety Group × Exposure Time interaction, $F(1, 60) = 3.09$, $p = 0.08$, $\eta_p^2 = 0.05$. There was no significant Exposure Time × Stimuli Type interaction, $F(1, 60) = 1.42$, $p = 0.24$, $\eta_p^2 = 0.02$. There was no significant three-way Anxiety Group × Exposure Time × Stimuli Type interaction, $F(1, 60) = 0.25$, $p = 0.62$, $\eta_p^2 = 0.00$.

4. Discussion

The present study is the first to examine the differences between attentional bias toward COVID-19-related and general threat-related stimuli in trait anxiety. Participants with high trait anxiety exhibited an attentional bias toward COVID-19-related stimuli and an attentional bias away from general threat-related stimuli, while participants with low trait anxiety showed an attentional bias away from both types of stimuli. The results indicate that individuals with high trait anxiety are more susceptible to chronic stress exposure and show specific attentional bias toward threatening information corresponding to their current worries.
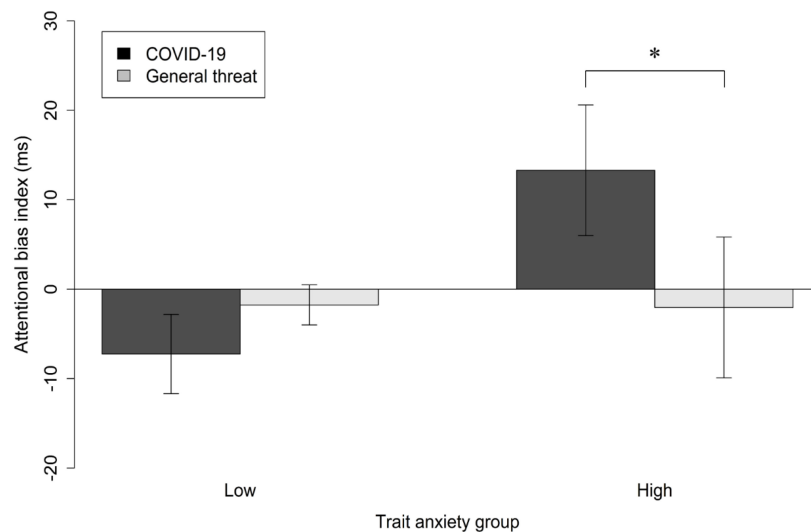
FIGURE 2

Attentional bias index (ms) for COVID-19-related and general threat-related words in the low and high anxiety groups. The error bars stand for Standard Errors.

We found the attentional bias toward COVID-19-related stimuli among individuals with high trait anxiety. This result aligned with previous studies which found a positive association between attentional bias toward COVID-19 stimuli and health anxiety (3) and COVID-19 anxiety syndrome (8). The COVID-19 pandemic could be regarded as a traumatic stressor (1). After experiencing traumas, individuals may develop pathological cognitive structures and are prone to interpret mild stimuli as threatening, especially those stimuli which are similar to their previous traumatic experiences (41). Thus, they are likely to exhibit excessive behavioral and psychological responses to these stimuli (30). However, these stimuli may be only moderately threatening or even neutral for individuals without corresponding trauma exposure. The susceptibility to trauma exposure is more pronounced in individuals with high trait anxiety due to their emotion dysregulation and severer stress responses (42, 43). Under repetitive exposure to COVID-19-related negative information, individuals with high trait anxiety may be more prone to develop a pathological learning pattern. They could learn from their previous negative experiences to fear COVID-19-related stimuli, show elevated sensitivity to potential COVID-19 threats, and allocate more attention to COVID-19-related stimuli. Although this selective attention allocation may have been adaptive during the initial stages of the COVID-19 pandemic, the persistence of such cognitive patterns may impede information processing and prolong anxiety symptoms (30). Thus, it is important to focus on individuals' mental health after a mass stressor such as the COVID-19 pandemic or natural disasters and provide psychological intervention.

Notably, we did not find an attentional bias toward general threat-related stimuli among individuals with high trait anxiety. This result was inconsistent with a previous meta-analysis which indicated a stable pattern of anxiety-linked attentional bias toward threats (4). The inconsistency could be explained by content specificity in anxiety-linked attentional bias. A meta-analysis revealed there was a greater attentional bias toward

disorder-congruent threatening stimuli than disorder-incongruent threatening stimuli (9). For example, Foa et al. (44) found among rape victims that trauma-related words elicited a stronger attentional bias than other threat-related words. Stefan et al. (45) found that among individuals with illness anxiety disorder, the disengagement bias was stronger for health-related stimuli than general threat-related stimuli. These results suggest that attentional bias is most significant when threatening stimuli correspond to an individual's current worries (46). According to several cognitive models, previous memory and learning could play a role in schema-driven threat processing (4, 47). During the COVID-19 pandemic, the perceived possibility of encountering general threats may have been low, while the worry of contamination and quarantine had become the core challenge. Although both COVID-19-related threats and general threats are biologically significant, the burden caused by COVID-19 threats is more pervasive and prolonged. Unlike short-term stress exposure, long-term stress exposure can result in severer physiological and behavioral dysregulation (48). Therefore, under chronic stress exposure to the COVID-19 pandemic, individuals with high trait anxiety may have learned to specifically fear COVID-19-related information, leading to corresponding attentional bias. Pergamin-Hight et al. (9) suggested future studies on attentional bias move beyond disorder-congruent content specificity to explore personalized specificity in more generalized disorders rather than disorders with a specific concern. The current study contributes to the field by exploring the relationship between trait anxiety and content specificity related to participants' personal experiences.

We did not find an attentional bias toward either COVID-19-related or general threat-related stimuli among individuals with low trait anxiety. This result is consistent with previous studies (4). Although it has been suggested that individuals with low trait anxiety also selectively attend to threats, the threshold of threat intensity required to elicit such an effect is higher (49). It is plausible that the word stimuli used in our study did not possess sufficient valence or "threat value" to induce an attentional

bias in individuals with low trait anxiety. In contrast to word stimuli, picture stimuli possess higher emotional salience (50) and may provoke stronger emotional reactions and attentional biases. We did not find significant association between exposure extent and attentional bias indexes. Previous research suggested trauma exposure may contribute to attentional bias via the activation of fear structure (51). The COVID-19 pandemic is characterized as pervasive and persistent, but less intense than common traumatic events (e.g., bereavement, natural disasters). It may be possible that the intensity of the COVID-19 pandemic as a stressor is not adequate to activate the fear structure. Moreover, the current study only measured objective exposure to the COVID-19 pandemic. Considering the heterogeneous psychological outcomes after the COVID-19 pandemic (1), subjective trauma exposure may have a stronger association with attentional bias.

About the components of attentional bias, we did not find a significant effect of exposure time on the attentional bias index. Participants with high trait anxiety showed attentional bias toward COVID-19-related stimuli and then maintained their attention, within the time course from 200 ms to 500 ms. In contrast, they at first biased away from general threat-related stimuli and then directed their attention to general threat-related stimuli. Participants with low trait anxiety showed an opposite pattern. These results align with a meta-analysis that found attentional bias in a wide range of exposure times among anxious individuals (4). However, it remains unclear whether the positive values of the attentional bias index are attributed to vigilance toward threats or delayed disengagement from threats. To address the limitation of the traditional attentional bias index, Koster et al. (52) introduced a variant version of the dot-probe task involving neutral-neutral stimuli pairs and found only delayed disengagement. Additionally, as indicated by Cisler and Koster (53), the components of attentional bias, mediating mechanisms (e.g., attentional control, emotion regulation goal), and stages of information processing may interact with each other. Thus, future research should use paradigms that separate vigilance from delayed disengagement and consider integrating mediating factors.

The current study has implications for increasing intervention efficacy, particularly for ABMT and post-disaster interventions. Prior meta-analyses examining ABMT have demonstrated small-to-medium effect sizes for reducing anxiety symptoms (54, 55). To improve the therapeutic effect, the nature of training stimuli needs to be considered (9). Given that attentional bias is influenced by personal experiences and concerns, a one-size-fits-all approach may not be effective in treating anxiety symptoms. An optimized intervention procedure could incorporate personalized content-specific threat stimuli, as the attentional bias toward such stimuli is stronger and may have a more significant impact on anxiety symptom maintenance than general threat-related information. Additionally, following a mass stressor, such as the COVID-19 pandemic or natural disasters, individuals with high trait anxiety are more prone to developing a pathological fear structure unique to their traumatic experiences, thus increasing the risk of anxiety disorders. Therefore, a timely intervention targeted at this vulnerable group is imperative to prevent maladaptive post-trauma responses and overgeneralized fear.

Despite the valuable contributions of the present study, certain limitations should be acknowledged. First, the sample size of the current study is only 62, which may be the reason why there is no significant correlation between trait anxiety and attentional bias. Previous studies which found a significant correlation between trait anxiety scores and attentional bias indexes had a larger sample size. For example, Salemink et al.'s study (2007) recruited 133 participants and Rudaizky et al.'s study (2014) recruited 72 participants. A larger sample size is needed to explore the linear relationship between trait anxiety and attentional bias. Second, the cross-sectional design precluded the ability to establish causal relationships between trait anxiety and attentional bias. To address this limitation, future investigations may consider implementing a longitudinal design to explore whether a bidirectional and mutually facilitating causality exists between anxiety and attentional bias (6). Additionally, the university student sample may not be representative enough of clinical samples. A Chinese sample with generalized anxiety disorder has a mean score on trait anxiety of 54.82 (56), whereas the high trait anxiety group in the current study has a mean score of 51.84. The extent of trait anxiety in the current study may not be adequate to elicit a strong effect of attentional bias. Thus, it is recommended that future research replicate the present findings among clinical samples with generalized anxiety disorders to determine the generalizability of the conclusions. Moreover, it is important to note that the traditional attentional bias index did not differentiate between vigilance toward threats and delayed disengagement from threats and response bias may have influenced the RT-based dot-probe task (29). To overcome these limitations, novel experimental methods with higher psychometric properties and moment-to-moment dynamic characteristics, such as eye-tracking and event-related potentials, are suggested for measuring specific cognitive processing stages (57, 58).

5. Conclusion

The present study contributes to the field by providing evidence on content-specific attentional bias toward COVID-19-related stimuli in trait anxiety. Participants with high trait anxiety exhibited an attentional bias toward COVID-19-related stimuli and attentional bias away from general threat-related stimuli, while participants with low trait anxiety showed attentional bias away from both types of stimuli. Our findings suggest several theoretical implications. We contribute to the field of content specificity by investigating personalized specificity in a group of individuals who shared similar chronic stress exposure. The current study also has clinical implications for ABMT and post-disaster intervention. The use of content-specific stimuli which are related to participants' personal experiences could improve intervention efficacy.

Data availability statement

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

Ethics statement

The studies involving humans were approved by the University Committee on Human Research Protection of East China Normal

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 contribution

YZ: Data curation, Writing—original draft. XJ: Investigation, Methodology, Writing—review and editing. SP: Software, Visualization, Writing—review and editing. HJ: Writing—review and editing. YW: Conceptualization, Funding acquisition, Methodology, Project administration, Resources, Supervision, Writing—review and editing.

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Conflict of interest

Publisher's note

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Appendix

Neutral words: 短语, 参数, 章节, 地毯, 广播, 胶卷, 食谱, 电视, 服装, 营地, 蜡烛, 墙壁, 期刊, 抽纸, 冰箱, 橱窗, 火车, 大厅, 飞机, 贴纸 (English version: phrase, parameter, chapter, carpet, broadcast, film, recipe, television, clothes, camp, candle, wall, journal, tissue, refrigerator, shopwindow, train, hall, plane, sticker).

COVID-19-related words: 口罩, 病毒, 传染, 采样, 发热, 肺炎, 隔离, 确诊, 密接, 疫情 (English version: mask, virus, contagion, nucleic acid test, fever, pneumonia, quarantine, diagnosis, close contact, pandemic).

General threat-related words: 暴力, 危险, 威胁, 谋杀, 攻击, 子弹, 杀害, 粗暴, 腐烂, 毒蛇 (English version: violence, danger, threat, murder, attack, bullet, kill, cruel, rot, snake).

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